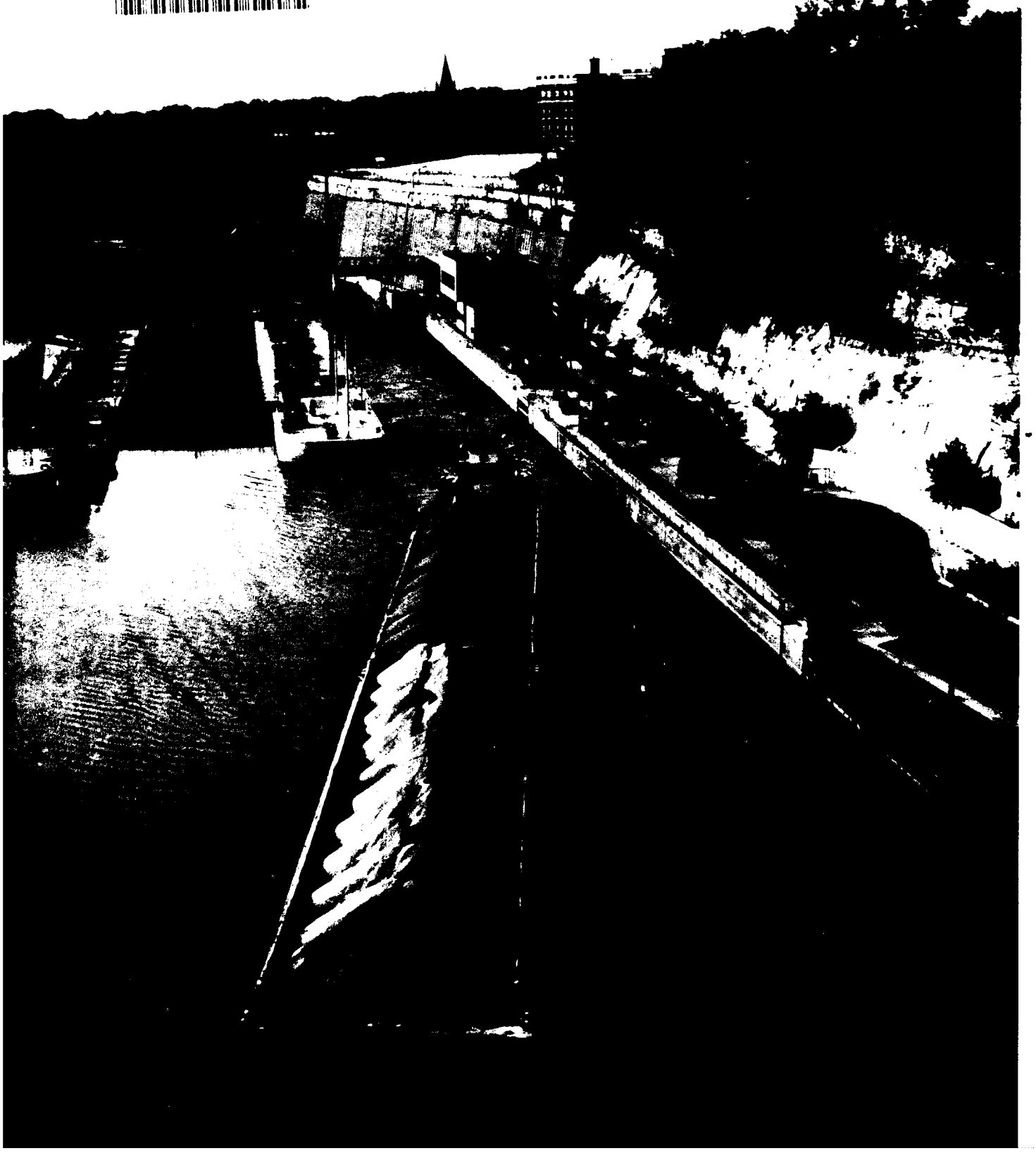
US Army Corps
of Engineers

Water Resources Development in Minnesota 1991



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This report details projects of the U.S. Army Corps of Engineers, St. Paul District that are completed, underway, or in the study stage in Minnesota. The rivers and lakes of the State of Minnesota drain into four distinct watersheds- the Upper Mississippi River Basin, the Souris-Red-Rainy Rivers Basin, the Great Lakes Basin, and a small drainage area the the southwestern corner of the State which belongs to the Missouri River Basin. The water resources projects of the U.S. Army Corps of Engineers include the extension and improvement of navigable waterways and construction of flood protection and multiple purposes works.

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UNCLASSIFIED

For more than 216 years, the missions and accomplishments of the U.S. Army Corps of Engineers have closely reflected the needs and wants of a growing, changing nation. For much of this time, the Corps has played a major role in our nation's water resources development, including navigation, flood control, water quality and supply, recreation and related projects.

Although the driving force behind our water resources development mission has remained constant—providing quality service to the nation—there have been several challenging adjustments in how we meet this requirement.

One such change was the introduction of non-Federal cost sharing in the Water Resources Development Act of 1986. Though legislatively reaffirmed in the subsequent acts of 1988 and 1990, the true value of cost-shared development can be measured by the many successful projects of this partnership and the healthy water resources program it ensures for the future.

Another challenge we have faced recently is the increased public concern for the environment. We have always complied with environmental laws and regulations and managed our projects as a trust we hold for the future. Compliance, however, is no longer enough. We are taking an active position to not only protect but enhance our fragile environment.

The Secretary of the Army has been directed to include environmental protection as one of our primary missions, and the Water Resources Development Act of 1990 established a "no net loss" policy as an essential part of all water resources development. In addition to making environmental considerations as important as engineering and economic considerations for new start projects, we are taking a new look at existing projects to determine how they can be environmentally improved.

Looking ahead to the needs of our nation, we are taking a lead role in helping rebuild our nation's aging infrastructure. The U.S. Army Corps of Engineers has always been at the forefront of infrastructure development in the United States—exploring new territory for settlement, surveying transportation routes and opening rivers to navigation. While we work to restore and strengthen the vital links in our infrastructure, we are also exploring new methods to meet increasing and varying national requirements. One such effort is a joint Federal, non-Federal demonstration project to determine the feasibility of a U.S. developed and built high-speed magnetic levitation transportation system.

We have also been working actively with the construction industry on a cost-shared Construction Productivity Advancement Research Program. This program has the double benefits of increasing the U.S. construction industry's competitive ability in the international market while providing more effective techniques, equipment and processes for Federal and non-Federal projects in the United States.

With these initiatives, we are building on the Corps' traditions of professionalism and service to meet the needs of our nation for another 200 years. We are proud of the partnerships we have forged, and look forward to an exciting, rewarding future in water resources development.

This booklet is one in a series detailing water resources programs in the 50 states and U.S. possessions. I hope you find it interesting and feel some pride of ownership.

H.J. HATCH
Lieutenant General, USA
Commanding

The U.S. Army Corps of Engineers has a long and proud history of applying its expertise in engineering and related disciplines to meet the Nation's needs. Over the years, those needs have evolved, from such 19th Century activities as exploration, pathfinding and lighthouse construction to such modern missions as hazardous and toxic waste removal and environmental improvement. The central focus of its Civil Works mission, however, has, from its earliest days, been development of the Nation's water resources.

The water resource projects developed by the Corps of Engineers, in cooperation with State and local project sponsors, have proven themselves time and again as wise investments of public funds, returning to the public in benefits—low cost transportation, flood damages prevented, etc.—far more than their cost to plan, build and operate. As a result, the Civil Works program enjoys a high degree of credibility within the Administration, and with Congress. With a program of more than $3.5 billion in Fiscal Year 1991, the Civil Works program was one of the very few "domestic discretionary" activities of the Federal government to receive an increase in funding that year.

Yet, proud as we are of the respect this program commands within the Federal government, we are even prouder of the trust that our partners—the States, local governments, port authorities, water management districts and other local project sponsors—place in us.

Each Corps of Engineers project is the product of on orderly study and design process. Under provisions of the Water Resources Development Act of 1986, sponsors demonstrate their commitment early in the project development process by agreeing to joint funding of the feasibility study upon which a project's construction authorization will be based, and to cost sharing of the project's construction once it is authorized. To date, more than 150 non-Federal sponsors have signed Local Cooperation Agreements for studies or congressionally authorized projects.

The engineering expertise and responsiveness of the Corps of Engineers, gained in the Civil Works and Support for Others programs as well as in its military construction role, has stood the Nation in good stead from Alaska, where it participated in the oil spill cleanup; to Puerto Rico, the Virgin Islands and the Southeastern States, where it spearheaded recovery efforts after Hurricane Hugo; to California in the aftermath of the Loma Prieta Earthquake; to the Midwest and California as they deal with continuing drought; to Panama and the Middle East in Operations JUST CAUSE and DESERT SHIELD/DESERT STORM.; to dozens of other locations. Whatever challenges arise in the years and decades ahead, I have no doubt that the Army Corps of Engineers will be equal to the task.

G. EDWARD DICKEY
Acting Principal Deputy Assistant Secretary of the Army
(Civil Works)

Foreword

This publication is a record of progress...a story of achievement by the U.S. Army Corps of Engineers in its work to improve the quality of our lives through water resources planning and development.

It explains the role of the Corps in the design, construction, operation and maintenance of navigation projects, flood and erosion control, hydroelectric power development, and other water related works. And it details projects that are completed, underway, or in the study stage.

Project and study classifications are:

Authorized Not Underway: (1) Projects or studies that have been authorized but have not been funded; (2) Projects or studies that have been funded at one time but not completed and now are classified as inactive or deferred.

Underway: Projects or studies that have been funded and are not yet complete. Projects may be substantially complete and functioning and still be listed as underway if some portion is still not complete and that portion has not been classified inactive or deferred.

Completed: (1) Projects or studies that are completed; (2) Projects or studies that are completed except for some items that have been classified as inactive or deferred.

Activities of the Corps are organized by lake and river basins. A description of each basin precedes project and study descriptions.

Because nature does not respect state boundaries, the work of the Corps in a particular state may fall within the jurisdiction of more than one Corps Division or District. The Division or District responsible for each undertaking is listed following the project or study title.

Project locations and Division/District boundaries are shown on maps in the Introduction section of this publication. Inquiries regarding specific projects should be addressed to the appropriate Division or District Commander:

Division Commander
U.S. Army Engineer Division, NORTH CENTRAL
River Center Building
14th Floor
111 N. Canal Street
Chicago, Illinois 60606-7205

District Commander
U.S. Army Engineer District, Rock Island
Clock Tower Building, Box 2004
Rock Island, Illinois 61201-2004

Division Commander
U.S. Army Engineer Division, MISSOURI RIVER
P.O. Box 103
Downtown Station
Omaha, Nebraska 68101-0103

District Commander
U.S. Army Engineer District, St. Louis
210 N. Tucker Boulevard
St. Louis, Missouri 63101-1986

District Commander
U.S. Army Engineer District, St. Paul
1421 U.S. Post Office & Custom House
St. Paul, Minnesota 55101-1479

District Commander
U.S. Army Engineer District, Detroit
P.O. Box 1027
Detroit, Michigan 48231-1027

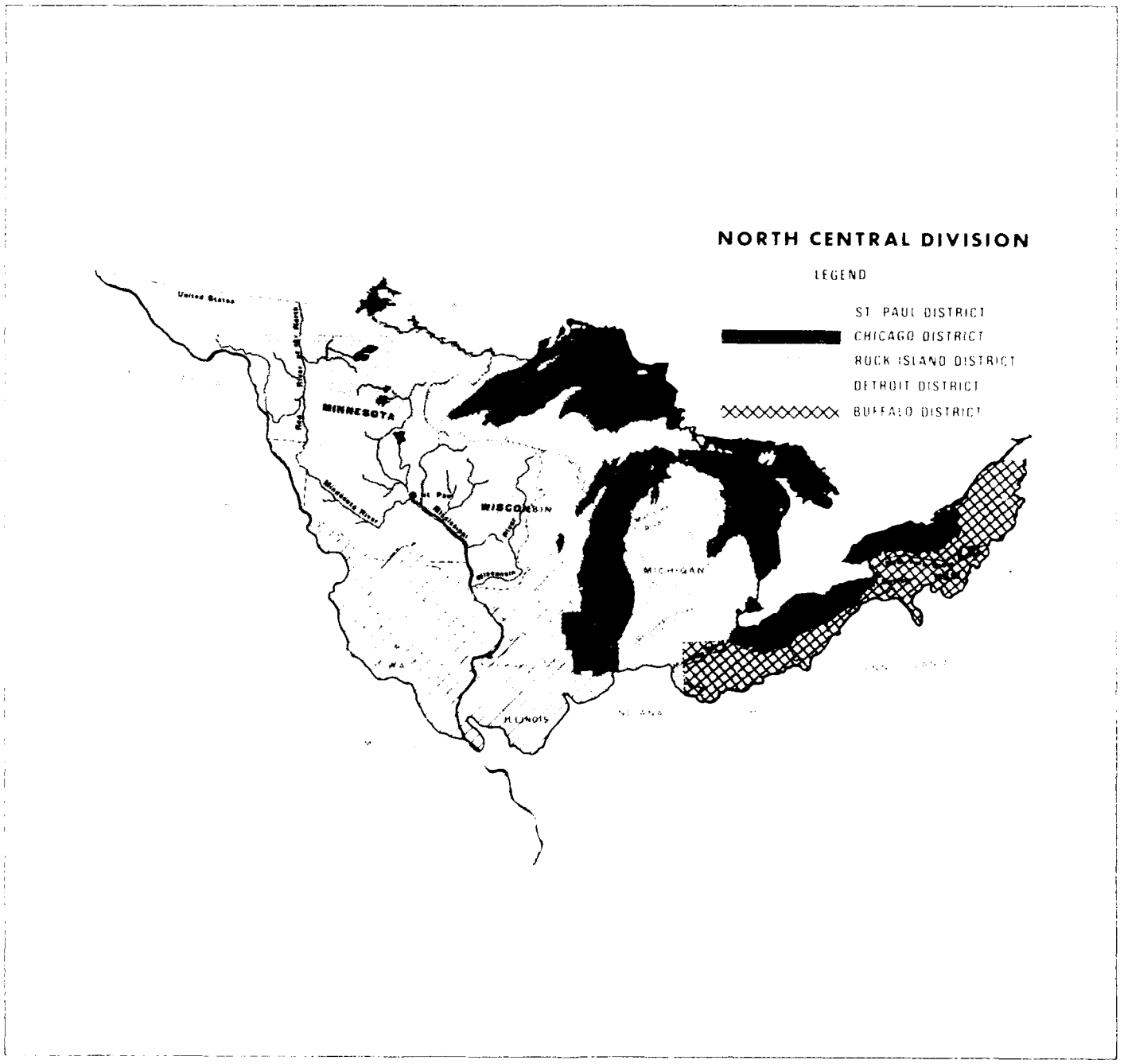
District Commander
U.S. Army Engineer District, Omaha
215 North 17th Street
Omaha, Nebraska 68102-4978

About the North Central Division

The North Central Division is responsible for water resource activities, including planning and development in all or parts of 12 midwestern states. The area included in the Division encompasses the Great Lakes basin, the Upper Mississippi River valley, and the watershed of the Souris-Red-Rainy rivers in northern Minnesota and North Dakota. Five districts carry out civil works activities in the Division: St. Paul, Chicago, Rock Island, Detroit, and Buffalo.

This "heartland of America" covers 428,000 square miles, or 11 percent of the total area of the United States. Twenty percent of the U.S. population—40 million people—live here, and the area includes 5 of the nation's 13 largest cities. The region's waterways are a major factor in its economic strength, environmental excellence, and the social well-being of its residents. The Division is seeking solutions to modern water resource problems, such as water pollution, environmental enhancement, flood damage, shore erosion, water supply, wastewater management, efficiency of water transportation, and water-related recreation.

Because of the geographical location of the Division, the Division Commander represents the United States on several U.S.-Canadian international boards concerned with boundary water matters of the two countries.



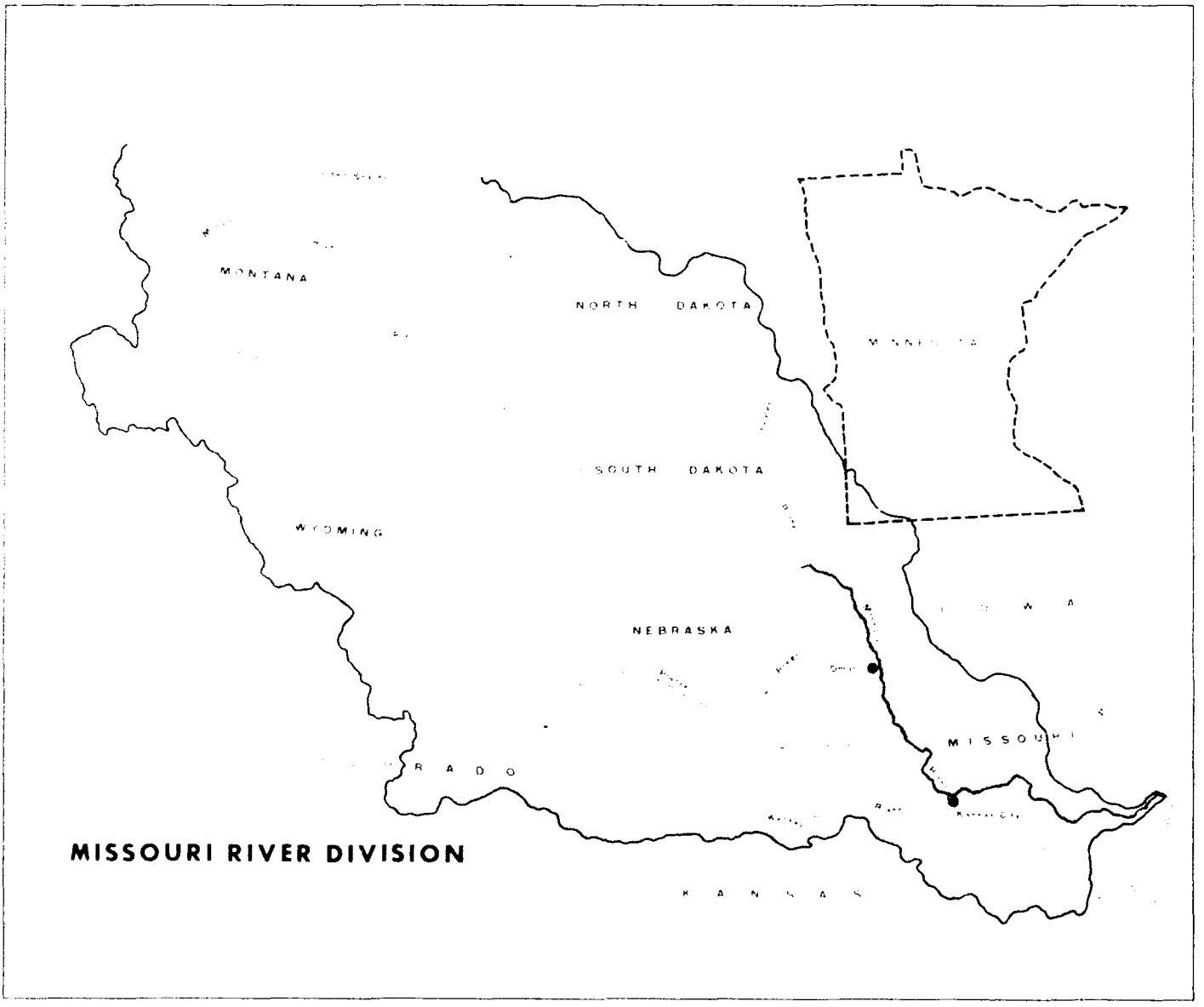
About the Missouri River Division

Conservation and development of water resources within the 529,000 square miles of the Missouri River Basin are the responsibilities of the Omaha-based Missouri River Division. All of Nebraska and parts of nine other states are included in the Division with work in the upper reaches handled by the Omaha District and lower basin under control of the Kansas City District. Corps efforts within the basin have prevented four billion dollars in flood damages.

The basin drains one-sixth of the contiguous United States and produces almost two-thirds of the nation's wheat, half the cattle and a quarter of all American feed grains. A region of startling contrasts, elevations within the basin range from 400 to 14,500 feet above mean sea level. Annual precipitation averages from six inches in the arid High Plains to more than 50 inches near the river's mouth. Temperatures from 120 degrees Fahrenheit to 70 degrees below zero have been registered.

The Division designed, built and operates two dozen dams on tributaries and provides many communities with flood control structures. In addition, MRD built and operates the six huge multi-purpose dams on the main stem of the Missouri, the primary elements of the Pick-Sloan Program. These six have total storage capacity of 75-million acre-feet, more than three times the average annual flow of the Missouri. Each year the main stem dams produce approximately 15 billion kilowatt-hours of pollution-free energy, provides a free-flowing commercially navigable stream from Sioux City, Iowa, to the Mississippi, offer needed flood protection, enhance fish and wildlife production and provide recreational opportunities for millions.

Erosion control, pollution reduction, ecological enhancement, waste water management, flood damage reduction and adequate water supplies for industry, agriculture and municipalities are high priority items for the Missouri River Division.



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Title Pages: Upper Mississippi River Region—Mississippi River below Lake Pepin; Upper Mississippi River Basin Main Stem and Headwaters—Lake Itasca, source of the Mississippi River; Minnesota River Basin—Minnesota River near Mankato; Cannon-Zumbro-Root Rivers Basin—Farmland along the Zumbro River; Souris-Red-Rainy Rivers Region—Red River of the North at Oslo; Great Lakes Region—Commercial ship on Lake Superior near Duluth; Lake Superior Basin— Sailboating near Duluth-Superior Harbor.

Chapter 1

Civil Works Overview

Introduction

The U.S. Army Corps of Engineers traces its history back to June 18, 1775, when Congress appointed Colonel Richard Gridley as Chief of Engineers of the Continental Army, under George Washington. The original Corps of Engineers was created in 1779, and it mustered out of service at the close of the Revolutionary War in 1783.

In 1802, Congress established a separate Corps of Engineers within the Army, and at the same time established the U. S. Military Academy at West Point, the country's first—and for 20 years its only—engineering school. With the Army having the Nation's most readily available engineering talent, successive Congresses and Administrations established a role for the Corps as an organization to carry out both military construction and works "of a civil nature".

Throughout the nineteenth century, the Corps supervised the construction of coastal fortifications, lighthouses, several early railroads, and many of the public buildings in Washington, DC and elsewhere. Meanwhile, the Corps of Topographical Engineers, which enjoyed a separate existence for 25 years (1838-1863), mapped much of the American West. Army Engineers served with distinction in war, with many Engineer officers rising to prominence during the Civil War.

In its civil role, the Corps of Engineers became increasingly involved with river and harbor improvements, carrying out its first harbor and jetty work in the first quarter of the nineteenth century. The Corps' ongoing responsibility for Federal river and harbor improvements dates from 1824, when Congress passed two acts authorizing the Corps to survey roads and canals and to remove obstacles on the Ohio and Mississippi Rivers. Over the years since, the expertise gained by the Corps in navigation projects made it a natural to assume new water-related missions in such areas as flood control, shore and hurricane protection, hydropower, recreation, water supply and quality, and wetland protection. Today's Corps of Engineers carries out missions in three broad areas: military construction and engineering support to military installations; reimbursible support to other Federal agencies (such as the Environmental Protection Agency's "Superfund" program to clean up hazardous and toxic waste sites); and the Civil Works mission, centered around navigation, flood control and—under the Water Resources Development Acts of 1986 and 1990—a growing role in environmental protection.

Authorization and Planning Process for Water Resources Projects

Water resources activities are initiated by local interests, authorized by Congress, funded by Federal and non-Federal sources, and constructed by the Corps under the Civil Works Program.

The Water Resources Development Act of 1986 made numerous changes in the way potential new water resources projects are studied, evaluated and funded. The major change is that the law now specifies non-Federal cost sharing for most Corps water resources projects.

When local interests feel that a need exists for improved navigation, flood protection, or other water resources development, they may petition their representatives in Congress. A Congressional committee resolution or an Act of Congress may then authorize the Corps of Engineers to investigate the problems and submit a report. Water resources studies, except studies of the inland waterway navigation system, are conducted in partnership with a local sponsor, with the Corps and the sponsor jointly funding and managing the study.

For inland navigation and waterway projects, which are by their nature not "local," Congress has established, in the Water Resources Development Act of 1986, an Inland Waterway Users Board, comprised of waterway transportation companies and shippers of major commodities. This Board advises the Secretary of the Army and makes recommendations on priorities for new navigation projects (e.g., locks and dams, channel improvements, etc.). Such projects are funded in part from the Inland Waterway Trust Fund, which in turn is fed by waterway fuel taxes.

Normally, the study process for a water resource problem will include public meetings to determine the views of local interests on the extent and type of improvements desired. The desires of local interests and the views of Federal, State, and other agencies receive full consideration during the planning process.

Considerations which enter into recommendations to Congress for project authorization include determinations that benefits will exceed costs, and that the engineering design of the project is sound, best serves the needs of the people concerned, makes the wisest possible use of the natural resources involved, and adequately protects the environment. A report, along with a final environmental impact statement, is then submitted to higher authority for review and recommendations. After review and coordination with all interested Federal agencies and Governors of affected States, the Chief of Engineers forwards the report and environmental statement to the Secretary of the Army, who obtains the views of the Office of Management and Budget before transmitting these documents to Congress.

If Congress includes the project in an authorization bill, enactment of the bill constitutes authorization of the project.

Before construction can get underway, however, both the Federal government and the local project sponsor must provide funds. Budget recommendations are based on evidence of support by the State and by the ability and willingness of non-Federal sponsors to provide their share of the project cost.

Appropriation of money to build a particular project is usually included in the annual Energy and Water Development Appropriation Bill, which must be approved by both Houses of the Congress and the President.

Navigation

Rivers and waterways were the primary paths of commerce in the new country. They provided routes from western farms to eastern markets. They promised a new life to the seaboard emigre' and financial reward for the Mississippi Valley merchant. Without its great rivers, the vast, thickly-forested, region west of the Appalachians would have remained impenetrable to all but the most resourceful early pioneers.

Consequently, western politicians such as Henry Clay agitated for Federal assistance to improve rivers. At the same time, the War of 1812 showed the importance of a reliable inland navigation system to national defense. Thus, both commercial development and military needs required attention to river and harbor development. There was, however, a question as to whether transportation was, under the Constitution, a legitimate Federal activity. This question was resolved when the Supreme Court ruled that the Commerce Clause of the Constitution granted the Federal Government the authority, not only to regulate navigation and commerce, but also to make necessary navigation improvements.

The system of harbors and waterways maintained by the Corps of Engineers remains one of the most important parts of the Nation's transportation system. Without constant supervision, rivers and other waterways collect soil, debris and other obstacles, which lead to groundings and wrecks. New channels and cutoffs appear frequently, and the main traffic lanes require continual surveillance.

Where authorized to do so, the Corps maintains the Nation's waterways as a safe, reliable and economically efficient navigation system. Inland waterways carry one sixth of the Nation's inter-city cargo, and one job in five in the United States is dependent, to some extent, on the commerce handled by the Nation's ports.

Flood Control and Flood Plain Management

Federal interest in flood control began in the alluvial valley of the Mississippi River in the 19th Century. As the relationship of flood control and navigation became apparent, Congress called on the Corps of Engineers to use its expertise in navigational work to devise solutions to flooding problems along the river.

After a series of disastrous floods affecting wide areas, including transportation systems, in the 1920's and 30's, it was recognized that the Federal Government should participate in the solution of problems affecting the public interest when they are too large or complex to be handled by States or localities. As a result, Corps authority for flood control work was extended in 1936 to embrace the entire country.

The purpose of flood control work is to prevent flood damage through flood flow regulation and other means. In addition, the Flood Control Act of 1944 provided that "flood control" shall include major drainage of land. These objectives are accomplished with structural measures, such as reservoirs, levees, channels and floodwalls, or non-structural measures which alter the way people would otherwise occupy or use the flood plain. Levees, channel improvements and flood walls built for flood control by the Corps of Engineers are turned over to non-Federal authorities for operation and maintenance.

Reservoirs constructed for flood control storage often include additional storage capacity for multiple-purpose uses, such as the storage of water for municipal and industrial use, navigation, irrigation, development of hydroelectric power, conservation of fish and wildlife, and recreation.

The Corps fights the Nation's flood problems by not only constructing and maintaining flood control structures, but also by providing detailed technical information on flood hazards. Under the Flood Plain Management Services Program, the Corps provides, on request, flood hazard information, technical assistance and planning guidance to other Federal agencies, States, local governments and private individuals. This information is designed to aid in planning for floods and regulation of flood plain area, thus avoiding unwise development in flood-prone areas. Once community officials know the flood-prone areas in their communities and how often floods would be likely to occur, they can take necessary action to prevent or minimize damages to existing and to new buildings and facilities by adopting and enforcing zoning ordinances, building codes, and subdivision regulations. The Flood Plain Management Services Program also provides assistance to other Federal agencies and to State agencies in the same manner. In many cases, fees are collected to cover a portion of the costs of these services.

Shore and Hurricane Protection

The Corps work in shore protection began in 1930, when Congress directed it to study ways to reduce erosion along U.S. seacoasts and the Great Lakes. Corps of Engineers hurricane protection work began in 1955, when Congress directed it to conduct general investigations along the Atlantic and Gulf Coasts to identify problem areas and determine the feasibility of protection. While each situation the Corps studies requires different considerations, engineers look at each one with structural and non-structural solutions in mind. Engineering feasibility and economic efficiency are considered along with the environmental and social impacts. A recommendation for Federal participation is normally based on shore ownership, use and type and frequency of benefits—if there is no public use or benefit, Federal participation is not recommended. Once a shore protection project is completed, non-Federal interests assume responsibility for its operation and maintenance.

Section 145 of the Water Resources Development Act of 1976 authorizes placement of beach quality sand from our dredging projects on adjacent beaches with local interests picking up the additional costs of the disposal. Section 933 of the Water Resources Development Act of 1986 reduces this local cost share from 100 to 50 percent of additional costs.

Hydropower

The Corps has played a significant role in meeting the Nation's electric power generation needs by building and operating hydropower plants in connection with its large multiple-purpose dams. The Corps' involvement in hydropower generation began with the Rivers and Harbors Acts of 1890 and 1899, which required the Secretary of War and the Corps of Engineers to approve the sites and plans for all dams and to issue permits for their construction. The Rivers and Harbors Act of 1909 directed the Corps to consider various water uses, including water power, when submitting preliminary reports on potential projects.

The Corps continues to consider the potential for hydroelectric power development during the planning process for all water resources projects involving dams and reservoirs. In most instances, hydropower facilities at Corps projects are now developed by non-Federal interests without Federal assistance, but the Corps becomes involved with the planning, construction and operation of hydropower projects when it is impractical for non-Federal interests to do so. Today, the more than 20,000 megawatts of capacity at Corps-operated power plants provide approximately 30 percent of the Nation's hydroelectric power, or 3.5 percent of its total electric energy supply.

Water Supply

The Water Supply Act of 1958 authorized the Corps to provide additional storage in its reservoirs for municipal and industrial water supply at the request of local interests, provided those interests agree to pay the cost. For irrigation, the Flood Control Act of 1944 provided that the Secretary of War, upon the recommendation of the Secretary of the Interior, may utilize Corps reservoirs, provided that water users agree to repay the Government for the water in accordance with the 1902 Reclamation Law, as amended.

Reservoir capacity can also be used for water quality and streamflow regulation, as authorized by the Federal Water Pollution Control Act Amendments of 1961.

Environmental Quality

In conducting its Civil Works Programs, the Corps must comply with many environmental laws and executive orders and numerous regulations relating to the environment. Consideration of the environmental impact of a Corps project begins in the early stages, and continues through design, construction and operation of the project. The Corps must also comply with many of these environmental regulations in conducting its regulatory programs (see next section).

The National Environmental Policy Act (NEPA) of 1969 is the national charter for the protection of the environment, and its procedures ensure that public officials and private citizens may obtain and provide environmental information before Federal agencies make decisions concerning the environment. Corps of Engineers project planning procedures under NEPA often point out the need for more extensive environmental studies, namely: the preparation of environmental impact statements. In selecting alternative project designs, the Corps strives to choose options with minimum environmental impact.

Under Section 1135 of the Water Resources Development Act of 1986, the Corps is authorized to modify its existing projects—many of them built before current environmental requirements were in effect—for environmental improvement. Proposed modifications under this authority range from use of dredged material to create nesting sites for waterfowl to modification of water control structures to improve downstream water quality for fisheries. Several of these proposals were specifically designed to help meet the goals of the North American Waterfowl Management Plan. The Corps is working to select additional projects for modification.

Regulatory Programs

The Corps of Engineers has regulatory authority over any construction or other work in navigable waterways under Section 10 of the Rivers and Harbors Act of 1899, and authority over the discharge of dredged or fill material into the "waters of the United States"—a term which includes wetlands and all other aquatic areas—under Section 404 of the Federal Water Pollution Control Act Amendments of 1972 (PL 92-500, the "Clean Water Act").

The Corps regulatory program is the principal way by which the Federal government protects wetlands and other aquatic environments, and ensures the continued navigability of the Nation's waterways. The regulatory program's goal is to ensure protection of the aquatic environment while allowing for environmentally sustainable development.

The standard permit evaluation process includes a public notice with a public comment period and an opportunity for a public hearing before the Corps makes a permit decision. In its evaluation of permit applications, the Corps considers all the relevant factors, including conservation, economics, aesthetics, general environmental concerns, historical values, wetland values, fish and wildlife values, flood damage prevention, land use classifications, navigation, recreation, water supply, water quality, energy needs, food production and the general welfare of the public.

The Corps of Engineers has issued a number of nationwide general permits for minor activities which require little or no individual review. Individual Corps districts have also issued regional permits for certain types of minor work in specific areas. Corps districts have also issued State Program General Permits in States with comprehensive wetland protection programs. These permits allow applicants to do work for which a State permit has been issued. These general permits reduce delays and paperwork for applicants and allow the Corps to devote its resources to the most significant cases while maintaining the environmental safeguards of the Clean Water Act.

Recreation

The Flood Control Act of 1944, as amended, provides authority to construct, maintain, and operate public park and recreational facilities at water resources development projects under the control of the Secretary of the Army and to permit the construction, maintenance, and operation of such facilities. It also provides that the water areas of projects shall be open to public use - generally for boating, fishing, and other recreational

purposes. The Corps of Engineers today is one of the Federal government's largest providers of outdoor recreational opportunities, operating more than 2,000 sites at its lakes and other water resource projects, and receiving more than 600 million visits per year.

Emergency Response and Recovery

Corps assistance for emergency/disaster response and recovery is provided under Public Law 84-99, covering Flood Control and Coastal Emergencies, or in support of other agencies, particularly the Federal Emergency Management Agency (FEMA) under Public Law 93-288 (the Stafford Act) as amended. Under PL 84-99 the Chief of Engineers, acting for the Secretary of the Army, is authorized to undertake activities including disaster preparedness, advance measures, emergency operations (e.g., flood fighting, rescue and emergency relief activities), rehabilitation of flood control works threatened or destroyed by flood, protection or repair of Federally authorized shore protection works threatened or damaged by coastal storms; and providing emergency supplies of clean water in cases of drought or contaminated water supply. In post-flood response activities, the Corps provides temporary construction and repairs to essential public utilities and facilities and emergency access for a 10-day period, at the request of the Governor.

Under the Stafford Act and the Federal Disaster Response Plan, the Corps of Engineers has a standing mission assignment to provide public works and engineering support in response to a major disaster or catastrophic earthquake. Under this Plan, the Corps will work directly with the State in providing temporary repair and construction of roads, bridges, and utilities, temporary shelter, debris removal and demolition, water supply, etc.

In addition to its mission under the Federal Disaster Response Plan, the Corps is one of the Federal agencies tasked by FEMA to provide engineering, design, construction and contract management in support of recovery operations.

Water Resources Development in Minnesota

The rivers and lakes of the State of Minnesota drain into four distinct watersheds — the Upper Mississippi River Basin, the Souris-Red-Rainy Rivers Basin, the Great Lakes Basin, and a small drainage area at the southwestern corner of the State which belongs to the Missouri River Basin. The water resources projects of the U.S. Army Corps of Engineers in these basins include the extension and improvement of navigable waterways and construction of flood protection and multiple purposes works.

Navigation

Corps of Engineers navigation projects in Minnesota are located along the north shore of Lake Superior, in Duluth Harbor at the westerly tip of the lake, and along the Mississippi River from the Iowa border to the head of navigation in Minneapolis. The 9-foot channel on the Minnesota River to a point 14.7 miles upstream from its mouth, and the 9-foot channel on the St. Croix to Stillwater are extensions of the Mississippi River navigation channel.

Commercial navigation on the Mississippi River has increased steadily since the advent of the 9-foot channel in 1935. Tonnages, for example, have nearly doubled in the Minneapolis-St.Paul area during the past decade. Although the impact of mine closings in northern Minnesota has been felt in the Lake Superior ports, the growth of overseas shipping has partially offset the tonnage losses. The development of the taconite industry in northern Minnesota has also materially increased tonnages on Lake Superior.

Flood Control

The U.S. Army Corps of Engineers has projects throughout Minnesota for flood control, water supply, and major drainage. On the Red River of the North, a number of projects (including Orwell Lake and Lake Traverse) work in concert with dams and reservoirs in North Dakota to reduce the danger of floods. Local protection works in tributaries adjacent to the Red River itself are integral parts of this flood control system. Lac qui Parle Lake and the projects at Marshall, Minneota, and Mankato and North Mankato, Minnesota, protect the lands and communities of the Minnesota River Basin. Along the Mississippi, the Aitkin, Hastings, Winona, and the St. Paul-South St. Paul flood control projects serve residents of those Mississippi River communities. The Rushford project on the Root River protects that community from floods.

Floods in Minnesota

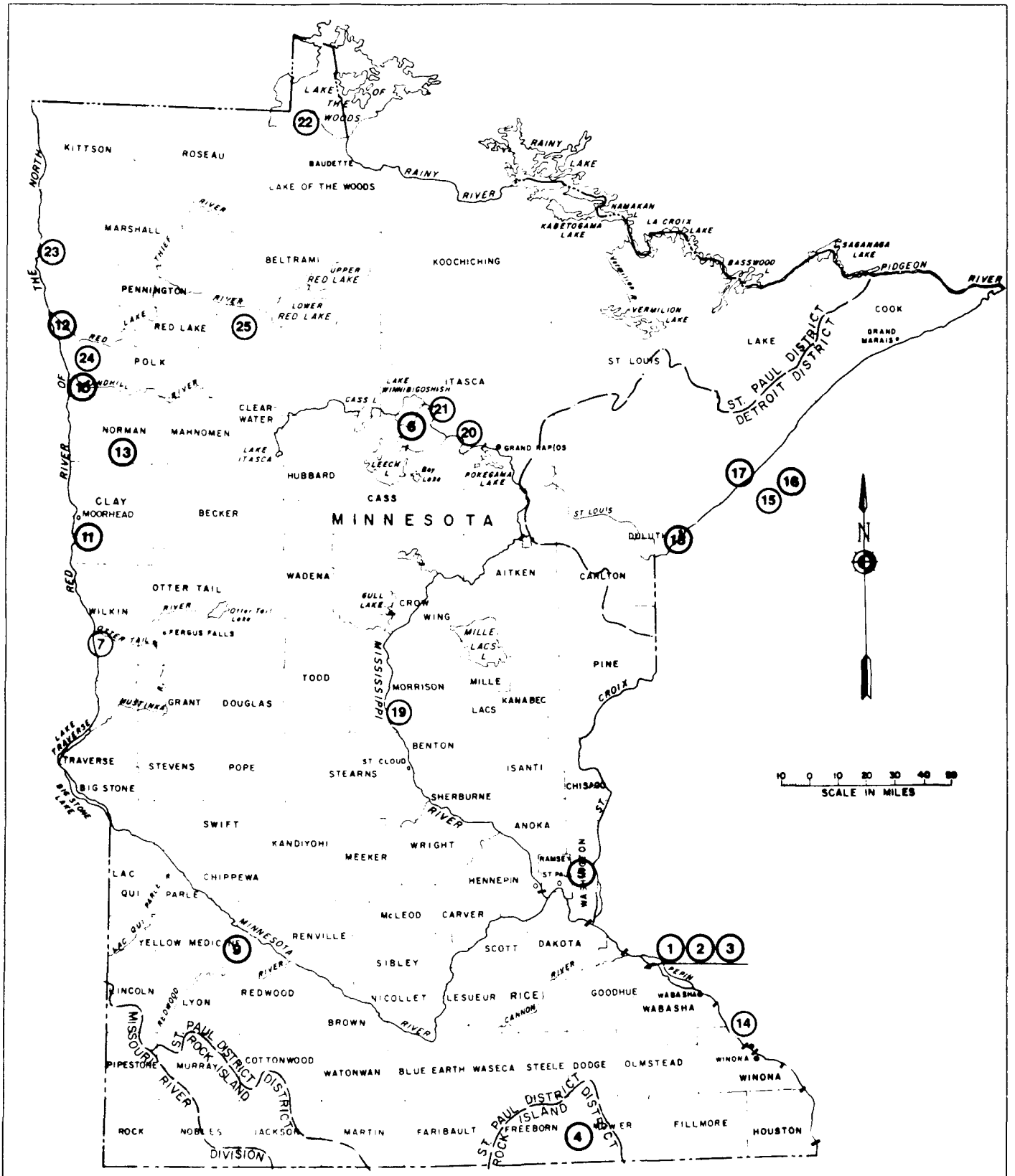
Floods are not new to the Mississippi and Red River of the North basins but the damage caused by floods increase as construction expands onto the low-lying lands adjacent to rivers. Severe flooding occurred in the Mississippi River basin in 1965, 1969, and 1978, and in the Red River of the North basin in 1966, 1969, 1975, 1978, 1979, and 1989. The flood of record on the Mississippi River occurred in 1965. Fifteen lives were lost and damages including flood fight costs in the basin exceeded $150 million. Damages prevented by existing Corps projects were approximately $40 million.

Recreational Development

Steadily increasing recreational use of the Upper Mississippi River has created the demand for additional public recreation facilities along the river. The Corps of Engineers has built a number of public use areas along the Mississippi River in Minnesota to help meet this recreational demand. These are part of the 9-Foot Channel Project. See the chart on the Mississippi River, Missouri River to Minneapolis, Minnesota, Corps of Engineers Recreation Areas.

In addition to the facilities on the Mississippi River, the Corps provides public facilities at nine project sites in Minnesota.

Project	Location	District Responsible
Gull Lake	West of Brainerd, Minnesota on County Road 125.	St. Paul
Lac qui Parle	Northwest of Montevideo,Minnesota on Minnesota Route 7 and 59.	St. Paul
Lake Traverse	Northwest of Wheaton, Minnesota on Minnesota Route 236.	St. Paul
Leech Lake	West of Grand Rapids, Minnesota on U.S. 2 and 8.	St. Paul
Orwell Lake	Southwest of Fergus Falls, Minnesota on County Road 15.	St. Paul
Pine River Lake	East of Brainerd, Minnesota on County Road 15.	St. Paul
Pokegama Lake	West of Grand Rapids, Minnesota on U.S. 2	St. Paul
Sandy Lake	North of McGregor, Minnesota on Minnesota Route 65.	St. Paul
Winnibigoshish Lake	Northwest of Deer River, Minnesota on County Road 9.	St. Paul



CORPS OF ENGINEERS
ACTIVE AND COMPLETED STUDIES
STATE OF MINNESOTA

Key to Water Resources Map
Active and Completed Studies

1 Upper Mississippi River Resource Management Study — GREAT (Special)

2 Upper Mississippi River Comprehensive Master Plan (Special)

3 Upper Mississippi River Main Stem Study (Comprehensive)

4 Iowa and Cedar Rivers (Flood Control)

5 St. Croix River (Flood Control)

6 Reservoirs at Headwaters of Mississippi River (Navigation)

7 Wahpeton, North Dakota — Breckenridge, Minnesota (Flood Control)

8 Minnesota River Valley Basin (Comprehensive)

9 Minnesota River (Navigation)

10 Red River of the North Basin (Comprehensive)

11 Fargo — Moorhead Urban Study (Multi-Purpose)

12 Grand Forks — East Grand Forks Urban Study (Multi-Purpose)

13 Wild Rice — March Rivers (Flood Control)

14 Mississippi River (Navigation)

15 Great Lakes Connecting Channels and Harbors (Navigation)

16 Great Lakes and St. Lawrence Seaway Navigation Season Extension Program (Navigation)

17 Two Harbors (Navigation)

18 Duluth (Shoreline Erosion)

19 Little Falls (Flood Control)

20 Headwaters Reservoirs of the Mississippi River (Multi-Purpose)

21 Lake Winnibigoshish (Multi-Purpose)

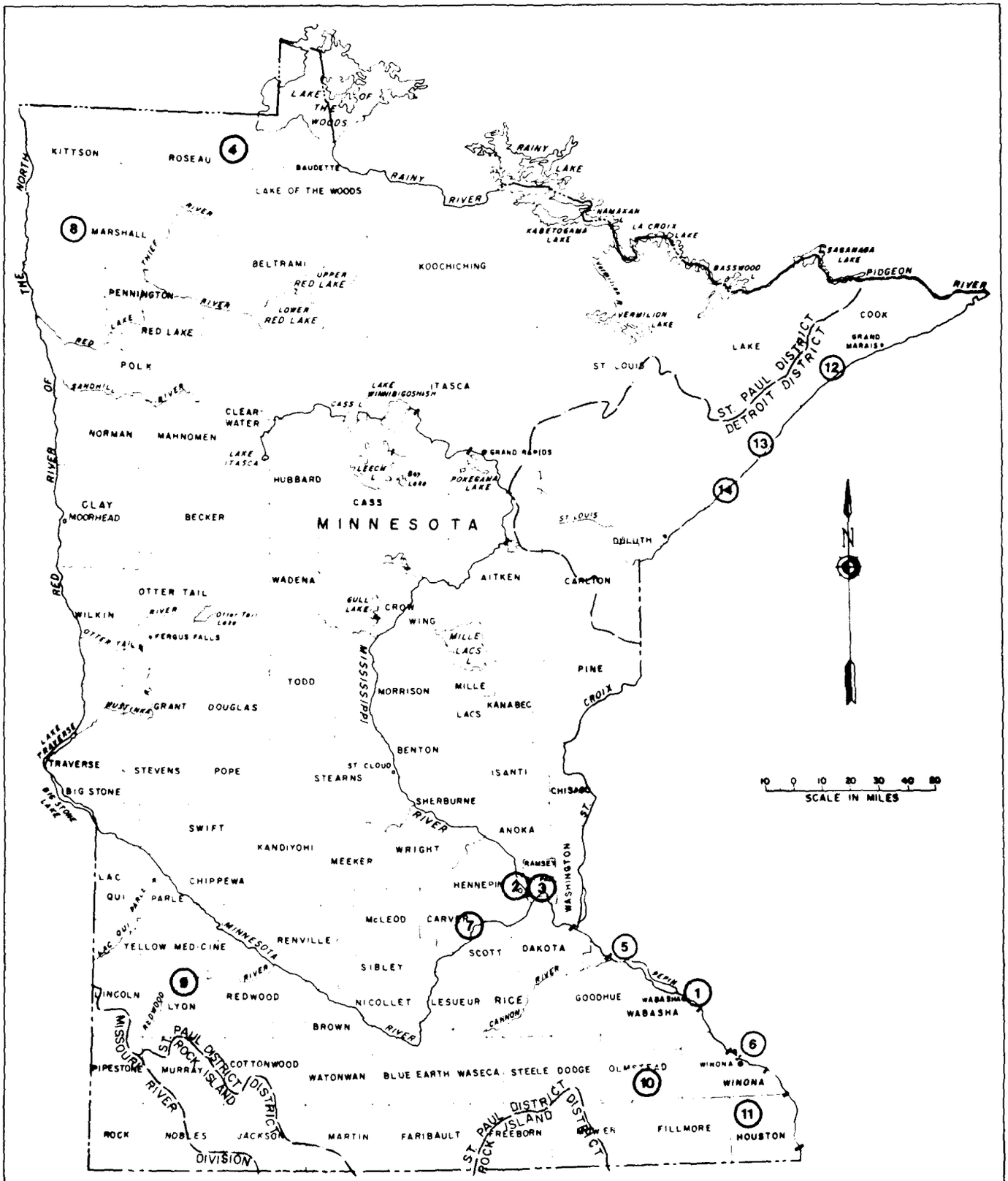
22 Lake of the Woods (Multi-Purpose)

23 Water Supply, Minnesota and North Dakota (Multi-Purpose)

24 Crookston (Flood Control)

25 Red Lake and Clearwater Rivers (Flood Control)

This list excludes the numerous small navigation, flood control, and emergency bank protection projects being pursued under the continuing authorities program.



CORPS OF ENGINEERS
ACTIVE PROJECTS
STATE OF MINNESOTA

Key to Water Resource Map
Active Projects

1 Upper Mississippi River System Environmental Management Program

2 Bassett Creek (Flood Control)

3 St. Paul, Mississippi River (Flood Control)

4 Roseau River (Flood Control)

5 Locks and Dams 2 - 10, Mississippi River (Major Rehabilitation)

6 Locks and Dams 3, 5A - 9, Mississippi River (Major Rehabilitation)

7 Chaska (Flood Control)

8 Middle River at Argyle (Flood Control)

9 Marshall (Flood Control)

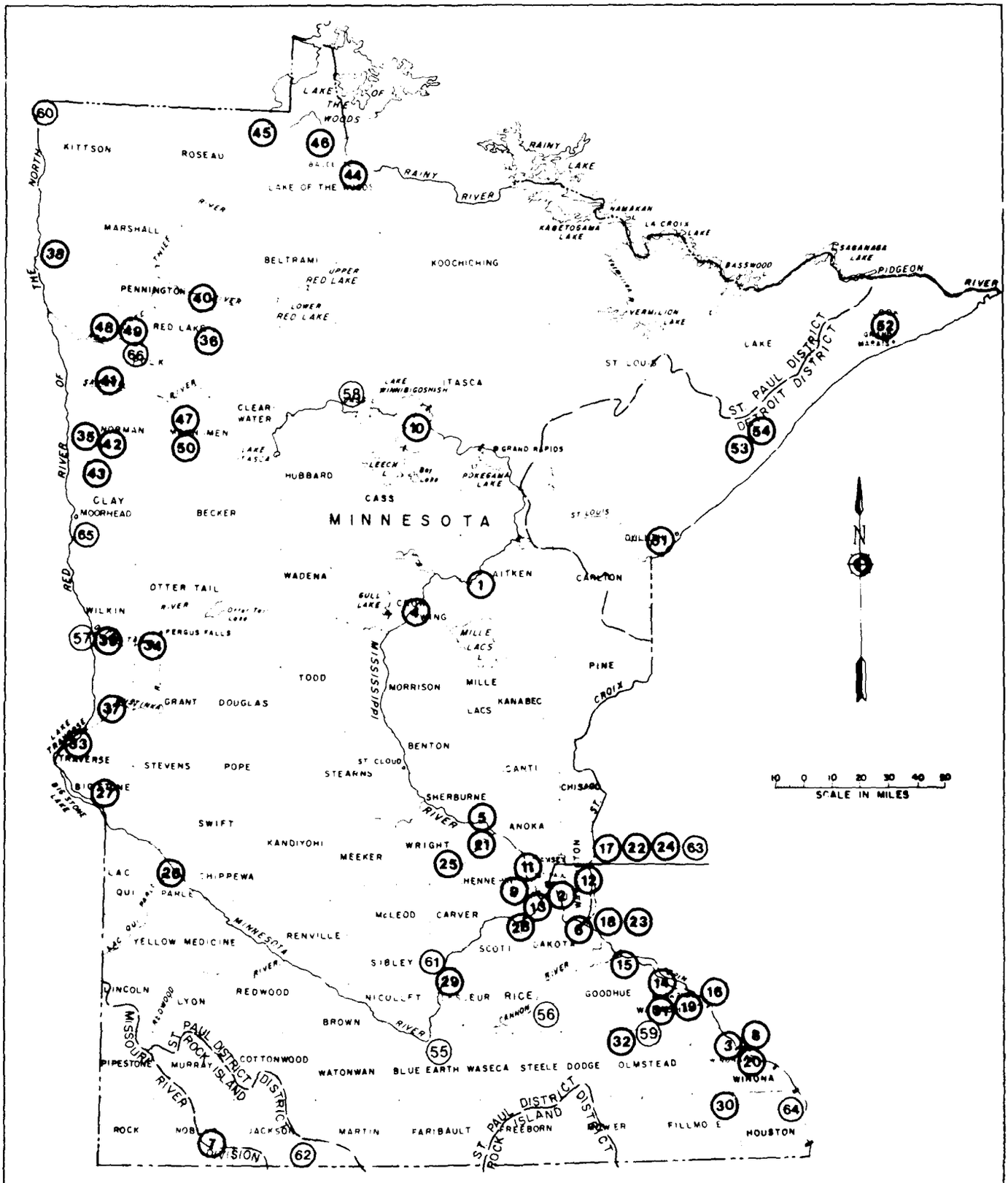
10 Rochester (Flood Control)

11 Houston (Flood Control)

12 Lutsen Harbor (Navigation)

13 Beaver Bay (Navigation)

14 Knife River Harbor (Navigation)



CORPS OF ENGINEERS
COMPLETED PROJECTS
STATE OF MINNESOTA

Key to Water Resources Map
Completed Projects

1 Mississippi River near Aitkin Diversion Channel (Flood Control)

2 St. Paul and South St. Paul (Flood Control)

3 Winona (Flood Control)

4 Black Bear - Miller Lakes (Flood Control)

5 Elk River (Flood Control)

6 Hastings, Vermillion River (Flood Control)

7 Okabena Creek, Worthington (Flood Control)

8 Crooked Slough Harbor at Winona (Navigation)

9 Minneapolis Harbor below St. Anthony Falls, Mississippi River (Navigation)

10 Reservoirs at Headwaters of Mississippi River (Navigation)

11 St. Anthony Falls Upper Harbor (Navigation)

12 St. Croix River (Navigation)

13 St. Paul Harbors (Navigation)

14 Lake City Harbors (Navigation)

15 Red Wing Harbors (Navigation)

16 Mississippi River between the Missouri River and Minneapolis, 9-Foot Channel Project (Navigation)

17 Lock and Dam No. 1 Major Rehabilitation, Mississippi River (Navigation)

18 Hastings Harbor (Navigation)

19 Wabasha Harbor (Navigation)

20 Winona Harbor (Navigation)

21 Elk River (Bank Protection)

22 Shepard Road at St. Paul (Bank Protection)

23 Veterans Memorial Levee at Hastings (Bank Protection)

24 Warner Road at St. Paul (Bank Protection)

25 Lake Pulaski (Flood Control)

26 Lac qui Parle Reservoir (Flood Control)

27 Big Stone Lake - Whetstone River (Flood Control)

28 Minnesota River (Navigation)

29 Minnesota River at Le Sueur (Bank Protection)

30 Root River and Rush Creek at Rushford (Flood Control)

31 Zumbro River Lower Reach (Flood Control)

32 Plum Creek, New Haven Township (Flood Control)

33 Lake Traverse and Bois de SiouxRiver (Flood Control)

34 Orwell Lake (Flood Control)

35 Halstad, Red River of the North (Flood Control)

36 Lost River (Flood Control)

37 Mustinka River (Flood Control)

38 Oslo, Red River of the North (Flood Control)

39 Otter Tail River (Flood Control)

40 Red Lake and Clearwater Rivers (Flood Control)

41 Sand Hill River (Flood Control)

42 Wild Rice - Marsh Rivers (Flood Control)

43 Wild Rice River - South Branch and Felton Ditch (Flood Control)

44 Baudette Harbor (Navigation)

45 Warroad River and Harbor (Navigation)

46 Zippel Bay Harbors (Navigation)

47 Mahnomen, Wild Rice River (Bank Protection)

48 Huot, Red Lake River (Bank Protection)

49 Red Lake Falls, Red Lake River (Bank Protection)

50 Wild Rice River, Mahnomen (Bank Protection)

51 Duluth - Superior Harbor (Navigation)

52 Grand Marais Harbor (Navigation)

53 Two Harbors (Navigation)

54 Two Harbors (Bank Protection)

55 Mankato and North Mankato (Flood Control)

56 Cannon River at Faribault (Bank Protection)

57 Breckenridge (Bank Protection) (2)

58 Andrusia Lake (Bank Protection)

59 Jarrett and Millville, Zumbro River (Bank Protection)

60 Emerson, Manitoba — Noyes, Minnesota (Flood Control)

61 Minnesota River at Henderson (Flood Control)

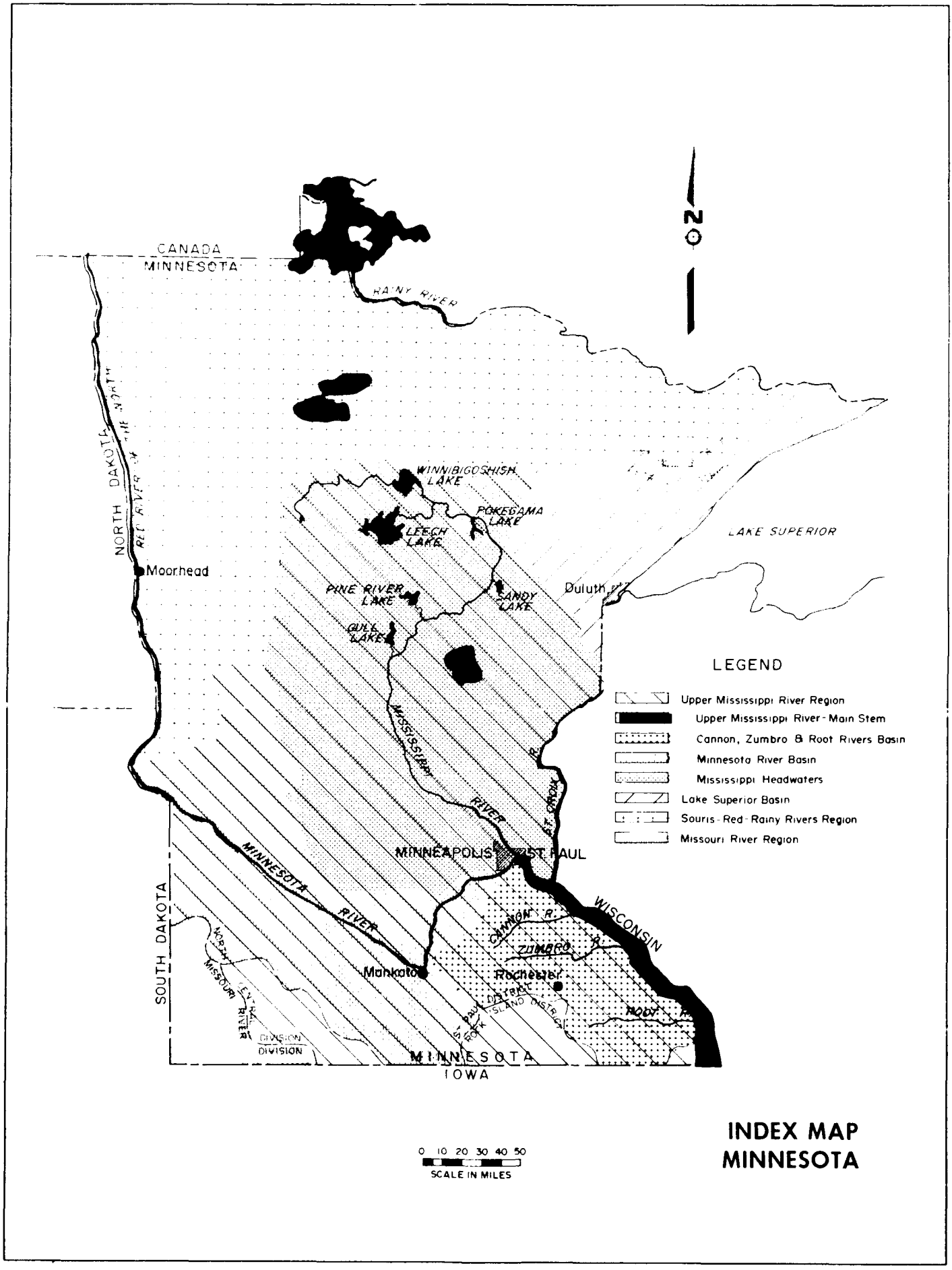
62 West Fork Des Moines River, Petersburg Township (Bank Protection)

63 Warner Road at Sibley Street (Bank Protection)

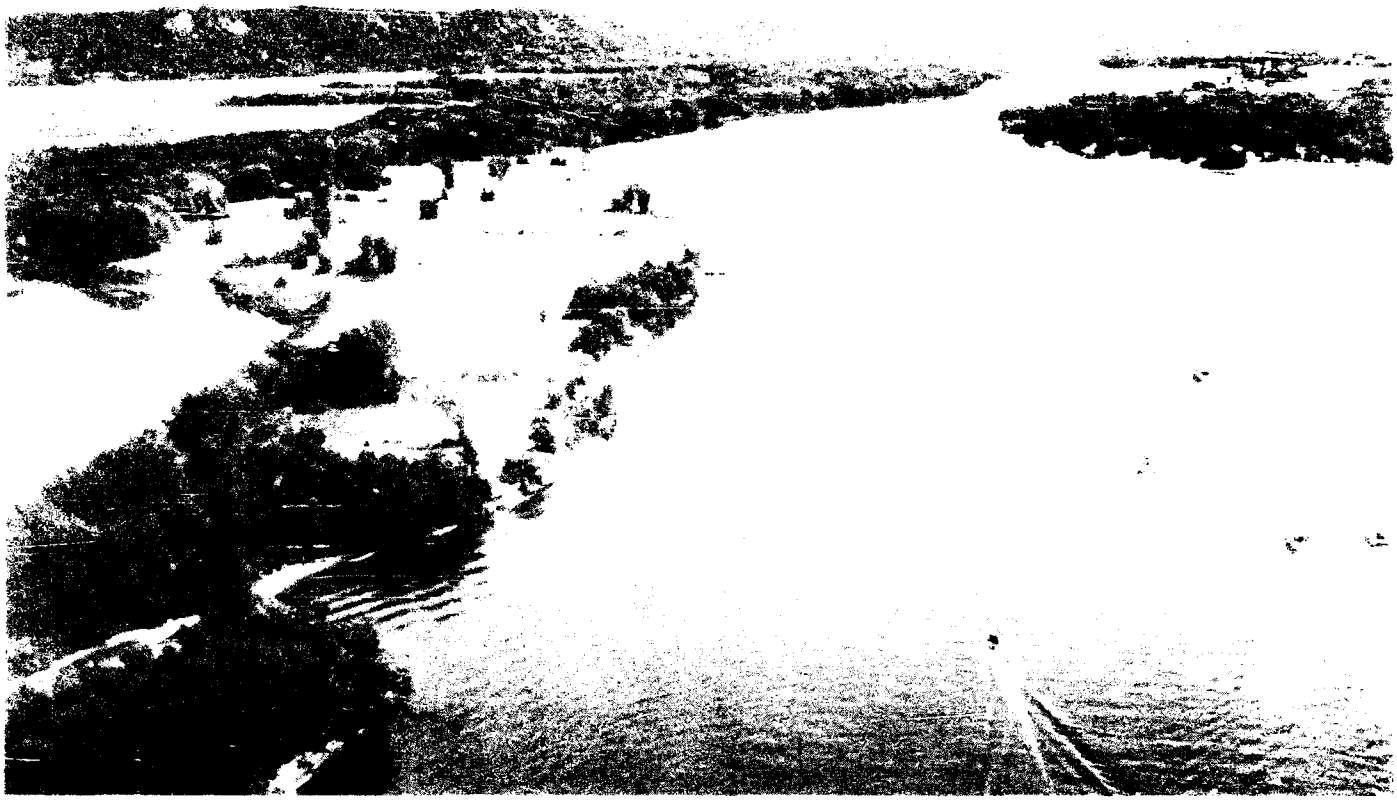
64 Root River at Hokah (Bank Protection)

65 Fargo - Moorhead (Flood Control)

66 Gentilly, Red Lake River (Flood Control)

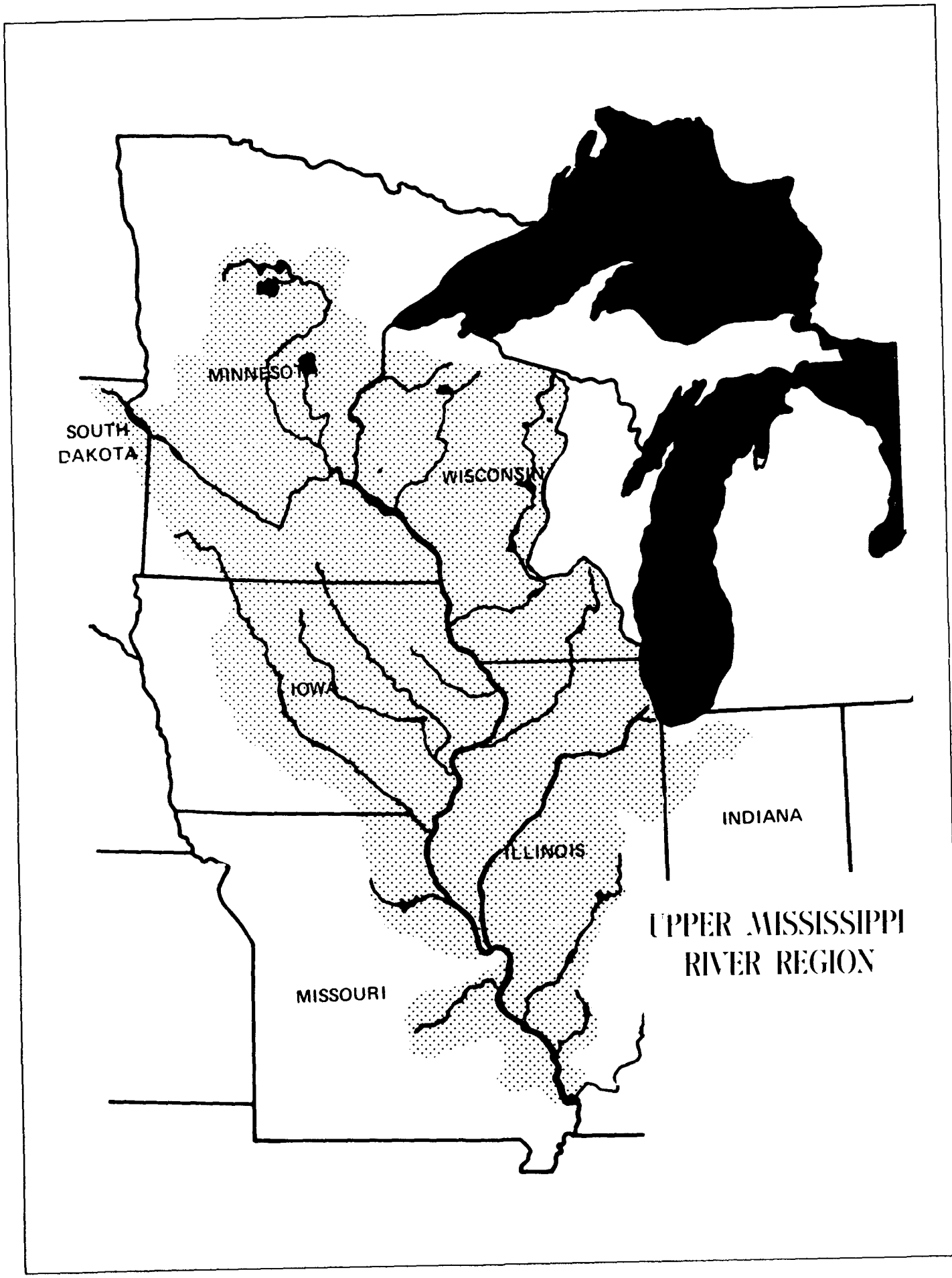


INDEX MAP
MINNESOTA



Chapter II

The Upper Mississippi River Region


MINNESOTA
SOUTH DAKOTA
WISCONSIN
IOWA
INDIANA
ILLINOIS
MISSOURI
UPPER MISSISSIPPI RIVER REGION

The Upper Mississippi River Region

The Upper Mississippi River Region extends almost 700 miles from near the Canadian border south to the mouth of the Ohio River. East to west it reaches some 500 miles across the Midwest, extending from Indiana to South Dakota. The region covers parts of eight states, an area of almost 121 million acres. It includes that part of the United States that is drained by the Mississippi River above its junction with the Ohio River at Cairo, Illinois, but the region does not include that portion drained by the Mississippi's major tributary, the Missouri River. The Missouri is the longest river in North America and drains an area about three times that drained by the Upper Mississippi. Because of the size of its drainage area, the Missouri and its tributaries are considered a separate river basin.

Environmental Setting and Natural Resources

The region contains some of the richest agricultural land on the continent. The north and south is mainly forest land; grasses are predominant in the east and west; and the central portion has an intermingling of grasses and forest. Some 3 million acres of the area is covered by freshwater lakes and streams. Over two-thirds of the basin is productive land suitable for agriculture. Mines, quarries, and oil wells are found in some areas. About 28 percent of the region is water, forest land, and other lands with great recreational portential. Federal, State, county, and local parks and recreation areas are abundant and 12 national wildlife refuges have been established.

Water and Land Resources

The region is one of the foremost regions of the world in both the quality and quantity of water and land resources. Water and related land resources in the basin are diverse. Land and water resource management programs have been designed to maintain the productivity of these levels to meet future requirements.

Land Resources

Over two-thirds of the 118 million acres of land in the Upper Mississippi River Region is used for agricultural production. Non-agricultural land use is primarily dictated by location. Urban and surburban areas have developed. Industry has located where natural and human resources are most prevalent. Recreational developments exist wherever suitable and accessible.

Urban areas are expanding at a rate of 80,000 acres each year, generally spreading out over adjacent farm land. Highways and recreational needs are also changing land use patterns rapidly. It becomes increasingly urgent to protect and conserve the land resources which we may need to use more intensively.

Approximately 80 million acres of the basin are susceptible to various types of damage that can be prevented by improved land management practices. About nine million acres are subject to flooding; another 25 million acres are being depleted by water and wind erosion. Some 20 million acres have inadequate drainage. Improved flood protection, conservation, and proper management can increase the productivity of these lands, enhance recreational values, and safeguard our valuable resources.

Water Resources

Water is an element indispensable to life. Not only does it sustain life, it also can be made to produce power, provide an economical means of transportation, and contribute to man's recreational enjoyment.

Currently, surface and ground water in the Upper Mississippi River Region are sufficient for rural, municipal, and industrial needs. There are many times, however, in some areas, when water supply is marginal, and there are many locations where the quality is poor. Sewage disposal is a problem in many communities. Sewage is discharged, treated or untreated, into lakes and streams from homes, industries, and commercial sources, and as a result of other urban and rural activities. Other forms of pollution also damage the natural water resources. Acid drainage, nutrient problems, thermal pollution, bacteriological pollution, oil pollution and sediment problems all impact on water quality. About two-thirds of the people in the region are supplied from surface water sources subject to some or all of these types of contamination.

Increasing demands for water use, accompanied by the realization that the supply is not inexhaustible, have resulted in an awareness of the need for control and conservation. Federal and State agencies have been assigned responsibilities to enhance the quality and value of water resources and to establish and monitor a national policy for preventing, controlling, and abating water pollution. Water quality standards have been set by each state in the region.

Fish and Wildlife

The Upper Mississippi River Region originally supported a wildlife population that included large portions of forest game. Settlement of the area and subsequent clearing of vast forest, along with the development of agricultural and industrial land uses, have changed the composition of the wildlife population toward game species — deer, cottontail, doves — that can coexist with man. Some fur-bearing animals still are plentiful, and numerous waterfowl are prominent in the region's wetlands and lakes.

Many natural lakes and streams provide excellent habitat for game fish. The Mississippi River itself provides thousands of acres of fish habitat and offers excellent fishing opportunities.

Aesthetics and Cultural Resources

There are many aesthetic and cultural areas in the region. National and State parks and forests, wilderness tracts, and wild and scenic areas are numerous. The region also is rich in heritage and has many points of historic significance.

Recreational Resources

Recreational use of the region's resources has increased substantially in recent years. At least one-fourth of the demand for outdoor recreation facilities in the region is for water-related

Wildlife on the Mississippi

activity. Nearly all accessible waters have experienced increasingly heavy use.

Enthusiasm for boating, camping, hiking, fishing, and picnicking creates a substantial impact on available resources. There is a wide variety of recreational development. Recreation has become a major industry — especially in the natural lakes portions of the region in northern Wisconsin and Minnesota. The area created by the navigation system on the Upper Mississippi River also attracts the attention of millions. The many historic sites dispersed throughout the region are still another attraction for many visitors each year.

Human Resources and Economy

The population of the Upper Mississippi River Region has grown rapidly in the two centuries since its settlement and is expected to continue. The 1980 population in the basin was about 22.5 million. Growth of cities and their influence have urbanized much of the area.

Major population centers are Chicago, St. Louis, Minneapolis-St. Paul, and the Quad Cities. There are also many thriving smaller cities in the region, reflecting our society's trend to urbanization.

Manufacturing, trade, and service industries employ more than half of the work force.

The mineral industry is an important economic factor of both the region and the nation. Commodities of national significance are bituminous coal, iron ore, lead, and zinc. Of importance to the region are sand, gravel, and stone.

Per capita income here is above the national average. This is at least partially the result of the land and water resources of the area, its mineral resources, and its central location in the nation and in the continent.

Navigation

The Upper Mississippi River Basin Navigation System consists of about 1,250 miles of navigable streams and plays a major role in the movement of bulk commodities to the nation's manufacturing centers. The Mississippi River and the Illinois River are the major navigation arteries. The rivers and several thousand miles of smaller streams also are available for recreational navigation and water-based recreation.

Demands for commercial navigation facilities and recreational navigation needs are increasing. Future needs for commercial navigation facilities may result in the region's waterways being expanded to include additional rivers in the region. The continuing trend to larger and more efficient tows will require continuing improvement of the waterways to handle growing traffic. Increased recreational demands will require harboring facilities for small craft and separating commercial and recreational traffic.

Mississippi River and Its Valley

The Mississippi River and its valley have a full and interesting history. Its striking beauty was noted by the earliest explorers and trappers.

Fishin' on the Mississippi

The character of the river and its valley changes several times as it flows nearly 2,350 miles south to the Gulf of Mexico. From its beginning at Minnesota's Lake Itasca, the "Father of Waters" meanders north to Lake Bemidji, along a lazy, winding course for about 80 miles. Downstream from Lake Bemidji, for 100 miles it runs east, stringing together a chain of azure lakes. It flows through swamps, lakes and second-growth pine forests, down small rapids, and between rising banks on its journey to the Falls of St. Anthony at Minneapolis. Passing diagonally through the business district of Minneapolis for four miles, it forms the boundary between the Twin Cities of St. Paul-Minneapolis. The Minnesota River, first major tributary of the Mississippi, flows into the Mississippi at the Twin Cities. From the Twin Cities, the Mississippi River winds through an 856-mile stretch of high bluffs, rolling hills, and wild wetlands, passing near prairie farms and more than 500 forested islands. On its journey, it is joined near Prescott, Wisconsin, by the St. Croix River. For the next 137 miles the Mississippi River forms the Minnesota-Wisconsin state line. It continues southward, and near Genoa, Wisconsin, becomes the state line dividing Iowa and Wisconsin. In this stretch, the Wisconsin River joins the Mississippi River.

The Mississippi River forms the entire 312-mile eastern boundary of Iowa and the entire western boundary of Illinois. Along this reach, major Illinois tributaries and several Iowa tributaries flow into the Mississippi. The Rock River joins the Mississippi immediately below Rock Island, Illinois. Further

Lock and Dam No. 2 at Hastings, Minnesota, is one of a series of locks and dams constructed and operated on the Upper Mississippi River by the U.S. Army Corps of Engineers to provide a stairway of water for commercial barges and pleasure boats.

downstream, the Illinois River — largest tributary of the Mississippi River above the mouth of the Missouri — flows into the Mississippi near Grafton, Illinois. Still further south, below East St. Louis, the Kaskaskia and the Big Muddy Rivers join. Iowa tributaries include the Turkey, Maquoketa, Wapsipinicon, Iowa, Cedar, Skunk, and the Des Moines Rivers. The Turkey flows into the Mississippi near the northern part of the state at Guttenberg, the Des Moines at the southern end of Keokuk. The others join the Mississippi River at random intervals and over the reach drain the eastern two-thirds of the State of Iowa. Tributaries draining the sections of the State of Missouri, which are included in the Upper Mississippi River Region, include the Fox, Wyaconda, and the Fabius Rivers.

The Upper Mississippi River Region ends at Cairo, Illinois, but the Mississippi continues southward passing through or past five more states on its journey to the Gulf of Mexico.

Upper Mississippi River System
Environmental Management Program
Special Project Underway
(North Central Division)

The Water Resources Development Act of 1986 authorized environmental management the Upper Mississippi River System to improve habitat for fish and wildlife; monitor and analyze the river's physical, chemical, and biological features; and expand recreational opportunities. This effort is called the Upper Mississippi River System Environmental Management Program (UMRS-EMP).

The system includes the navigable portion of the Mississippi River from its confluence with the Ohio River to Minneapolis-St. Paul; and the Saint Croix and Black Rivers. The UMRS-EMP seeks to improve the environmental resources of the river and provide a basis for the future management of those resources.

The 1986 Act charges the U.S. Army Corps of Engineers with implementing the UMRS-EMP. The Corps coordinates with the Department of Interior and other Federal agencies; the Upper Mississippi River Basin Association, and the States of Illinois, Iowa, Minnesota, Missouri, and Wisconsin, in carrying out this program. The 1990 Water Resources Development Act extended program authorization an additional five years. The Upper Mississippi River Basin association serves as a clearinghouse for state involvement in the program.

The U.S. Fish and Wildlife Service (FWS) is conducting the resource monitoring and analysis element of the program. Monitoring the river system and analyzing the results will help planners and managers understand the system's complex morphology, chemistry, and biology. Data collection will focus on habitat degradation and long-term environmental trends to detect and predict changes in the river's ecosystem. Resource managers can use the information to make decisions to reduce the effect of undesirable events in the river system.

Three Corps of Engineer Districts (St. Paul, Rock Island, and St. Louis) manage habitat rehabilitation and enhancement projects within their boundaries. Projects are proposed by the states and the FWS with the Corps of Engineers responsible for design and construction. Most of these projects address the impacts of side channel and backwater sedimentation. Each project typically involves use of one or more of the following techniques:

— Dredging to remove sediment from selected backwater and side channels to restore flow and/or provide deep water habitat.

— Levee construction to keep silt-laden water out of prime habitat areas or to control water levels. Water control structures and pump stations also may be included.

— Island construction to reduce the effect of wind, creating habitat for aquatic and terrestrial plants and animals.

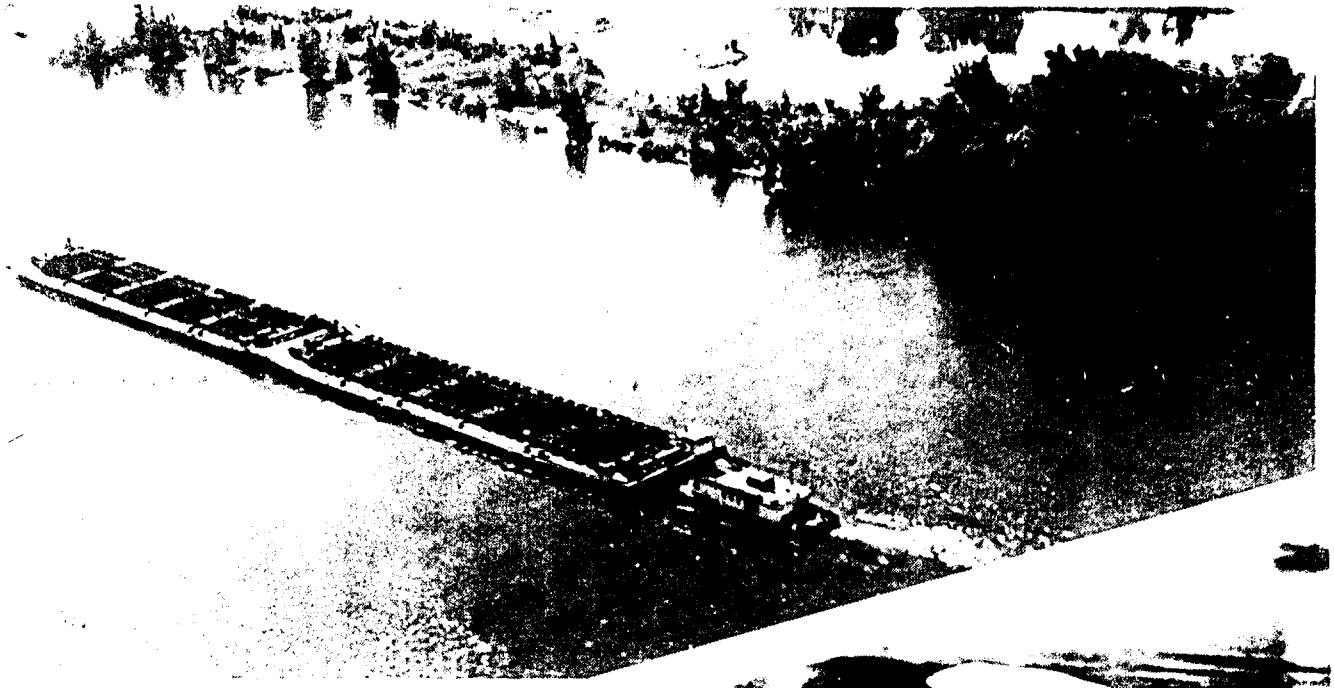
Each project will be closely monitored to refine techniques and to assure optimal results. Analysis of each project will help in the design of similar projects in other areas of the river system. In Minnesota, the following habitat rehabilitation and enhancement projects are in various stages of planning or construction:

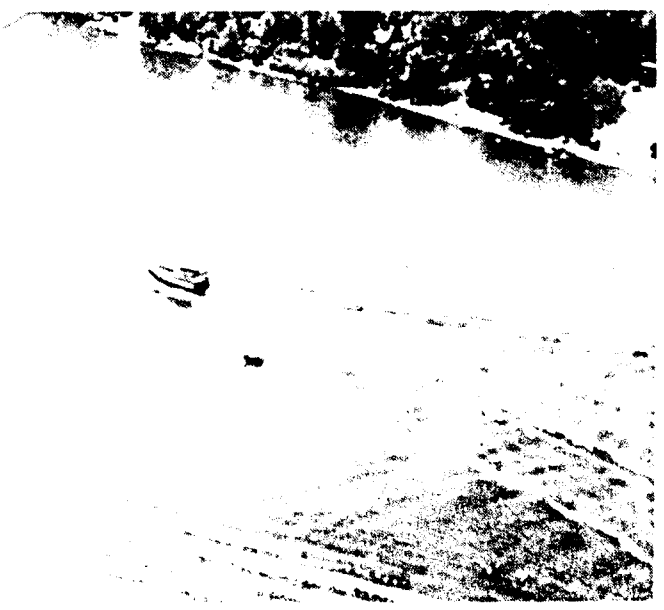
Island 42: This fisheries improvement project was completed in 1987. It consisted of excavating a side channel in Island 42 to provide fresh water to a valuable backwater fishery area and dredging a portion of the backwater to provide deepwater fish habitat. Total Federal cost of the habitat project was $262,000.

The Finger Lakes (fish) project is scheduled to begin construction in 1992. Planning and design are proceeding on projects at Goose Lake (fish and waterfowl), Polander Lake (waterfowl), North Lake (waterfowl and fish), Peterson Lake (waterfowl), and Mississippi River Bank Stabilization projects in Minnesota.

Upper Mississippi River
Resource Management Study (GREAT), I
Special Study Completed
(St. Paul, Rock Island and St. Louis Districts)

In the early 1970's the Corps of Engineers completed an Environmental Impact Statement (EIS) which described the effects of the operation and maintenance program for the nine-foot channel project on the Upper Mississippi River. The EIS concluded that sediment from uplands and stream banks, as well as localized disposal of dredged material, was filling in the river's biologically productive backwaters, marshes, and sloughs. In response, the Corps of Engineers and the U.S. Fish and Wildlife Service established the acronym "GREAT", under the sponsorship of the Upper Mississippi River Basin Commission. The Upper Mississippi River Basin Commission was composed of the State and Federal agencies that had a legislated interest or mission affecting the Upper Mississippi River. The Corps of Engineers, with its many activities on the river, was a member of the Commission and was a lead agency in the study. GREAT I encompassed the St. Paul District, from the head of navigation through Lock and Dam No. 10 at Guttenberg, Iowa; GREAT II





covered the Rock Island District, incorporating the reach of the river from Guttenberg to Lock and Dam No. 22 at Saverton, Missouri; and GREAT III covered the St. Louis District from Lock and Dam No. 22 to Cairo, Illinois. The studies investigated various areas of river management, but concentrated on the Corps of Engineers' channel maintenance project, particularly the dredging and disposal of dredged sand from the river. The St. Paul and Rock Island Districts later completed reports describing how they will implement the appropriate recommendations from GREAT I and GREAT II. These reports were reviewed and approved by the Board of Engineers for Rivers and Harbors on March 9, 1982. The GREAT III report was subsequently completed by the St. Louis District.

Implementation of GREAT I recommendations is coordinated through the St. Paul District's interagency Channel Maintenance Forum. Implementation of GREAT II recommendations is coordinated through the Rock Island District's interagency River Resources Coordinating Team.

Implementation of GREAT-recommended actions is essential to the environmental preservation of the Upper Mississippi River and to the long-range operation and maintenance of the nine-foot navigation project.

Upper Mississippi River Comprehensive Master Plan, Special Study Completed
(St. Paul, Rock Island, Chicago, and St. Louis Districts)

In October 1978, Public Law 95-502 authorized the construction of a new dam and a 1200-foot lock at Alton, Illinois, and directed the Upper Mississippi River Basin Commission to prepare a Comprehensive Master Plan for the Management of the Upper Mississippi River System.

The Commission completed its report and submitted it to Congress on December 31, 1981. The report recommended that Congress immediately authorize the engineering, design, and construction of a second chamber, 600 feet in length, to complement the new 1200-foot chamber at the Locks and Dam 26 replacement project. Non-structural and minor structural improvements were recommended at other locks in the system, in addition to monitoring of traffic movements to gather data for future use in evaluating possible improvements to the navigation project.

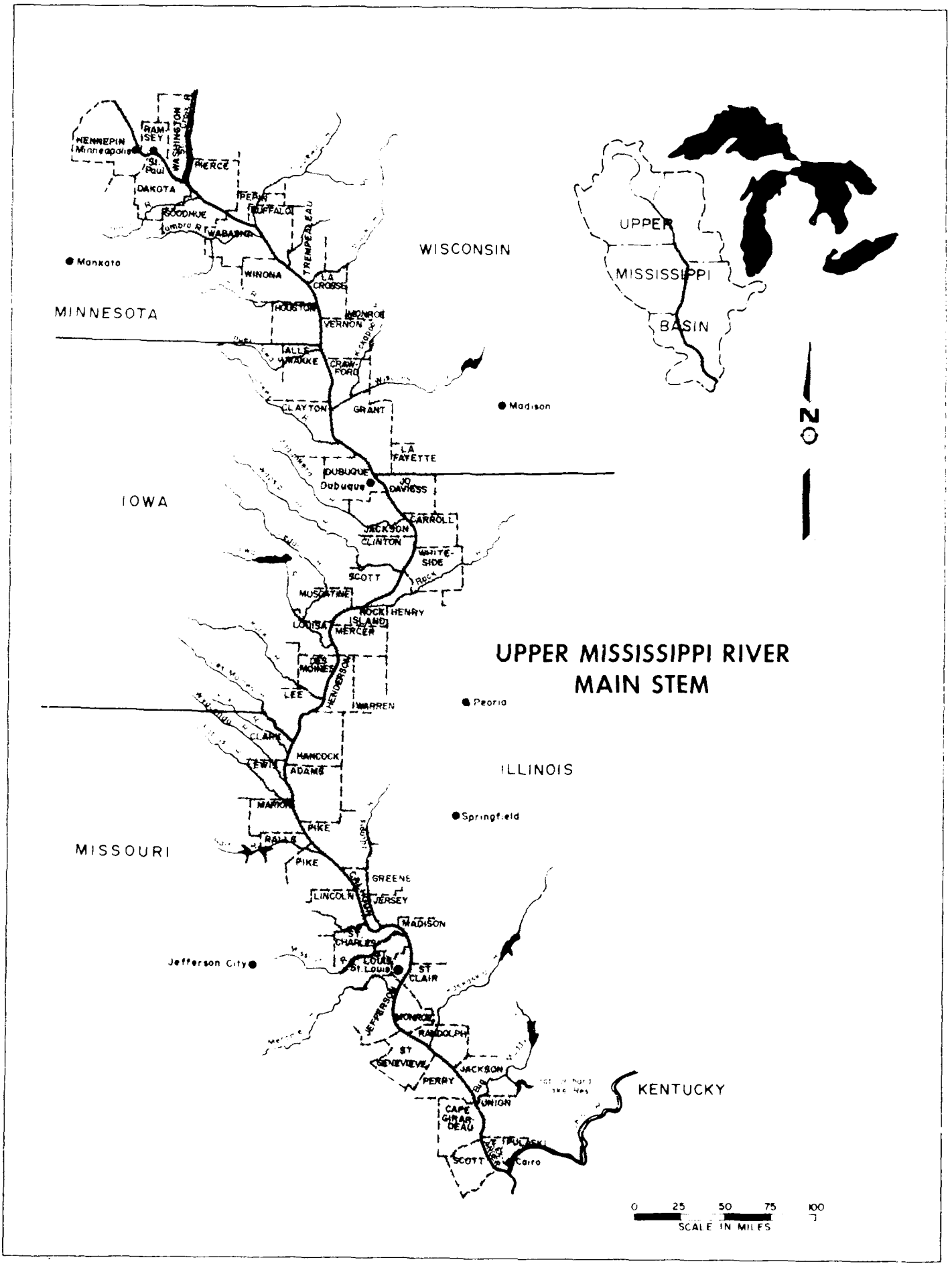
The Master Plan proposed a 10-year environmental program that would include habitat rehabilitation and enhancement projects. Also recommended were a long- term resources monitoring program with a computerized analysis and retrieval system, a program to develop Federally-owned lands for recreation, and an assessment of regional economic benefits generated by people using the river for various recreational activities.

The Commission concluded that disposing of dredged material out of the floodplain is generally not necessary, and that the Corps of Engineers should continue its present dredged material disposal practices. The Commission also recommended increased funding for Soil Conservation Service programs to reduce upland erosion, and hence, sedimentation of the river.

The Upper Mississippi River Basin Commission was abolished along with all other basin commissions, by Executive Order 12319 on January 1, 1982. The five affected States (Illinois, Iowa, Minnesota, Missouri, and Wisconsin) have since established the Upper Mississippi River Basin Association to coordinate interagency water resources planning and to further the implementation of the recommendations of the Master Plan study.

Chapter III

Upper Mississippi River Basin Main Stem and Headwaters


UPPER MISSISSIPPI RIVER
MAIN STEM
UPPER
MISSISSIPPI
BASIN
NO
WISCONSIN
MINNESOTA
IOWA
ILLINOIS
MISSOURI
KENTUCKY
Mankato
Madison
Dubuque
Peoria
Springfield
Jefferson City
Cairo
HENNEPIN
Minneapolis
St Paul
RAMSEY
WASHINGTON
DAKOTA
GOODHUE
WABASHA
PIERCE
PEPIN
BUFFALO
TREMPEALEAU
WINONA
LA CROSSE
HOUSTON
MONROE
VERNON
ALLAMAKEE
CRAWFORD
CLAYTON
GRANT
LA FAYETTE
DUBUQUE
JO DAVIESS
JACKSON
CLINTON
CARROLL
WHITESIDE
SCOTT
MUSCATINE
ROCK ISLAND
HENRY
LOUISA
MERCER
DES MOINES
HENDERSON
LEE
WARREN
CLARK
HANCOCK
LEWIS
ADAMS
MARION
PIKE
RALLS
PIKE
GREENE
LINCOLN
JERSEY
MADISON
ST CHARLES
ST LOUIS
St Louis
ST CLAIR
JEFFERSON
MONROE
RANDOLPH
ST GENEVIEVE
PERRY
JACKSON
UNION
CAPE GIRARDEAU
ALEXANDER
SCOTT
0 25 50 75 100
SCALE IN MILES

Upper Mississippi River Basin Main Stem and Headwaters

Mississippi River Main Stem

The Mississippi River is one of the most commonly known geographic features of the world. This river, called "Father of Waters" centuries ago, has played a prominent role in shaping our country. A pageant of history has occurred along the Mississippi. It first carried the canoes of the Indians and fur trappers; next rafts and boats of the early homesteaders; then logs during the lumbering era boom. Today, it serves as an economic and environmental lifeline for mid- America. The Mississippi is a major carrier of goods of commerce and industry for the central part of our nation. Its most vital role in the domestic transportation system is the long distance movement of bulk commodities. More than 700 shipping terminals are located along the Mississippi and its tributaries. The number of commercial tows and the volume of tonnage have increased rapidly since the present navigation system became operational in 1940.

From north-central Minnesota to St. Louis, Missouri, the Mississippi winds some 1,250 miles forming the borders between several states. Water from the Minnesota, St. Croix, Wisconsin, Rock, Turkey, Maquoketa, Wapsipinicon, Cedar, Iowa, Des Moines, and the Illinois Rivers, as well as smaller streams, flow into the Mississippi between Minneapolis and St. Louis. Just north of St. Louis, the massive Missouri River flows into the Mississippi. Still further south, at Cairo, Illinois, the broad Ohio River pours in and from there south the Mississippi River become the brawling giant of legend, flowing nearly a thousand miles in great loops through its wide, fertile valley to the Gulf of Mexico. The portion of the river from Cairo south is known as the Lower Mississippi River.

The Mississippi River and its valley are known for their striking beauty. Congress has recognized this through the establishment of the Upper Mississippi River Wildlife and Fish Refuge. The refuge follows the river from the mouth of the Chippewa to Clinton, Iowa. Throughout the woodlands, islands, marshes, natural lakes, and streams is a variety of fish and wildlife. The Upper Mississippi River is a quality fishery resource, and fishing is excellent at many locations. Spectacular migration of birds is noted in the spring and fall. Even the bald eagle, our national symbol, winters in numbers in refuge areas along the river. Furbearers and other mammals, plus about 40 smaller non-game species, are abundant.

The river and its resources offer splendid potential for public recreation. Each year millions visit the river to observe wildlife, to fish or hunt, to enjoy the pleasures of picnicking and boating, or simply to relax in the beauty and serenity of the environment. Interest in recreational boating has increased rapidly.

Mississippi River Headwaters

The Mississippi Headwaters area is composed of 27 counties in Minnesota and five counties in Wisconsin, with a total land area of 28,000 square miles. The estimated population in 1989 was 3.0 million. Almost 75 percent of the people live in the seven-county Minneapolis-St. Paul metropolitan area.

Major rivers in this area are the Mississippi and St. Croix. The Mississippi starts in north central Minnesota, about 1,400 miles above its juncture with the Ohio River. The St. Croix begins about 25 miles south of Lake Superior, with the first 40 miles of its route in Wisconsin. For the remaining 135 miles, this river forms the Minnesota-Wisconsin boundary. The topography reflects the advances and retreats of glaciers that once covered the area. Glacial deposits range from a few feet to several hundred feet thick.

The more than seven million acres of forest support a great variety of wildlife. This is one of the few remaining places in the United States where wilderness birds and animals such as the moose, timber wolf, black bear, marten, fisher, snowshoe hare, spruce partridge and osprey still survive. The white- tailed deer and waterfowl provide excellent hunting. Fishing conditions attract many. However, some of the southern lakes have been aging at a faster rate and water pollution problems have reduced the quality of stream fisheries.

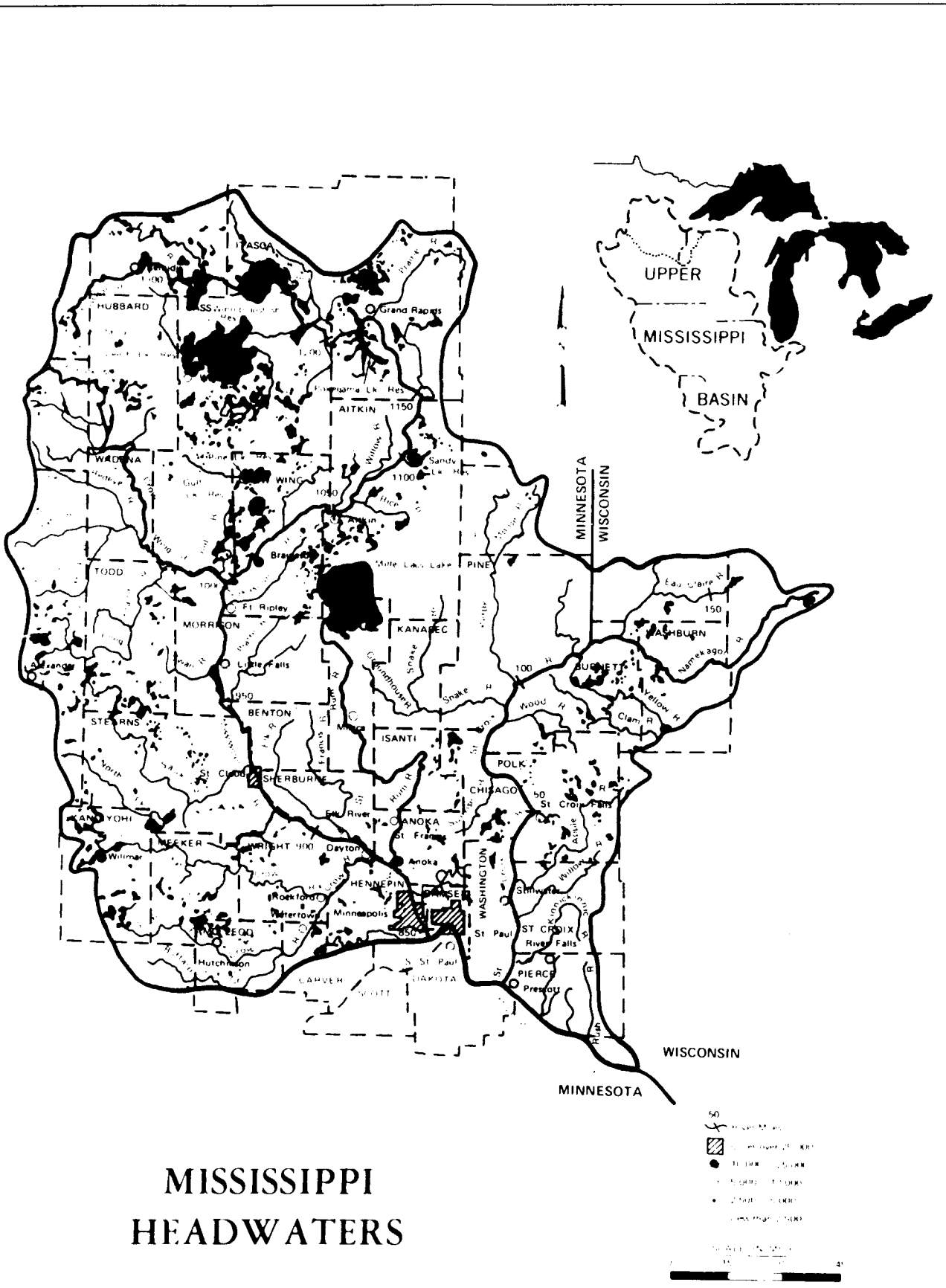
In general, water quality is good, although moderate erosion problems have resulted in some coloration of lakes and streams. The waters of the Upper Mississippi and the St. Croix are highly colored by tannic acid, especially during spring runoffs, and eutrophication may be a serious problem in some areas. Water quality problems exist in the Mississippi River downstream from St. Cloud through Minneapolis-St. Paul.

Increased agricultural production could be attained through flood prevention, improved drainage and irrigation on 3.1 million acres of crop and pastureland by the year 2020. The major needs in the area are to reduce flood damages, to provide additional public access for recreation, and to preserve the environment.

Upper Mississippi River Main Stem Study
Comprehensive Study Completed
(St. Paul, Rock Island, and
St. Louis Districts)

The Upper Mississippi River Main Stem Level B Study considered the area along the river and its flood plain between bluffs from Cairo, Illinois to Hastings, Minnesota, a total area of 2,900 square miles.

The study, conducted under the direction of the Upper Mississippi River Basin Commission, developed a total river comprehensive coordinated Federal-State-local overview of critical region resources and formulated an integrated set of recommendations for planning and managing water and related land resources. The study produced a regional plan the incorporated the findings of ongoing studies in the context of two broad objectives: national economic development and environmental quality.



MISSISSIPPI HEADWATERS

Cost for the study, which was completed in 1981, was $1,200,000 ($900,000 Federal and $300,000 State). The Corps of Engineers' share of the Federal cost was $120,000. Three Corps districts were involved in the study and were funded as follows: St. Paul, $12,000; Rock Island, $52,000; and St. Louis, $56,000.

Headwater Reservoirs of the Mississippi River, Authorized Multipurpose Study Not Underway
(St. Paul District)

Located in north-central Minnesota, the 6 Mississippi Headwaters Lakes are part of a multi-purpose Corps of Engineers reservoir project. (See Reservoirs at Headwaters of Mississippi River, Completed Project - Commercial Navigation.) All 6 lakes were natural lakes that were raised by the construction of dams and containment levees. The lakes support commercial navigation on the Upper Mississippi River, flood control, Indian Treaty Trust resources, sport and commercial fisheries, wild rice, fish and wildlife, and low flows that contribute to instream uses and water supply for municipal, industrial and agricultural uses as far downstream as the Minneapolis-St. Paul Metropolitan area. A study, authorized by Section 116 of the Water Resources Development Act of 1990, will investigate fluctuating lake levels from operation of project dams that contribute to inhibited production of natural resources and causes severe shoreline erosion. Lake currents move the sediment to cover walleye spawning reefs in these valuable sport fisheries. Lake level fluctuations also affect production of other valuable natural resources, including Treaty Trust resources used by 2 different bands of the Minnesota Chippewa Tribe. The operation of the dams has interrupted the natural cycle of water level fluctuations, limiting production of some natural resources. It is expected that the study will result in recommendations for modified water control for the project lakes that are consistent with authorized purposes and would maximize production of Treaty Trust and other natural resources. Results are also expected to contribute to the North American Waterfowl Management Plan and may contribute to Section 1135 projects in the area. Water control modifications might include new or varied target pool levels and possible new discharge targets for non-flood control situations. Engineering, hydrologic, operational, legal, and economic operating constraints as well as Indian Trust responsibilities would be considered in the study to maximize production of natural resources. To date, no funds have been provided to initiate the study.

Lake Winnibigoshish, Authorized Multipurpose Study Not Underway
(St. Paul District)

Lake Winnibigoshish is located in north-central Minnesota and is the 5th largest lake in Minnesota. The lake is widely recognized for its walleye fishery and environmental attributes. Water levels of the lake are controlled by a Corps of Engineers dam, one of the 6 Mississippi River Headwaters Reservoirs for commercial navigation on the Upper Mississippi River system. Much of the lake's shoreline is owned and managed for timber production by the U.S. Forest Service. Fluctuating water levels due to project regulation, combined with wind and wave action on extremely erodible shoreline, have long caused significant shoreline erosion problems. Only limited success has been gained by past uncoordinated attempts to stop the erosion. Within the past few years, the erosion has begun causing significant property and environmental damage. Some of the eroding shoreline areas have been leased to individuals who have constructed residences and seasonal homes. It is also now recognized that the eroded materials have been moved by lake currents and are covering highly productive rocky lake substrate and prime walleye spawning beds. A study, authorized by Section 116 of the Water Resources Development Act of 1990, would involve coastal engineering analysis and design to provide protective works to reduce shoreline erosion and protect spawning beds from deposition of shoreline materials. There may also be opportunities to restore spawning beds once the coastal dynamics are better understood. In accordance with the authorizing language, the study will also consider whether the Secretary's (Army) jurisdiction should be expanded to include areas above the current pool regulation levels related to the effects of pool level fluctuation. The Forest Service has been promoting cooperative problem solving with the Minnesota Department of Natural Resources and Corps of Engineers to attempt to resolve this problem. To date, no funds have been provided to initiate the study.

Mississippi River near Aitkin Diversion Channel, Completed Project, Flood Control — Local Protection
(St. Paul District)

The project, on the Mississippi River near Aitkin, authorized by the 1948 Flood Control Act, provided for a diversion channel about six miles in length bypassing Aitkin to alleviate flood conditions. Short channels diverting the Little Willow River and Wakefield Creek into the main diversion channel and erosion control structures at several points also were included. Cutoffs at Pine Knoll and Two Head Rapids were constructed downstream from the main diversion. Work was completed in 1957 at a cost of $1,675,800.

The project has prevented an estimated $4,977,000 in damages through September 1990.

St. Paul and South St. Paul, Mississippi River, Completed Project, Flood Control — Local Protection
(St. Paul District)

The 1958 Flood Control Act authorized protection of the Mississippi River at St. Paul and South St. Paul. St. Paul District designed the project to protect about 1.75 miles of river frontage

and 500 acres of land on the river's right bank in St. Paul and to protect business and industrial developments in South St. Paul.

St. Paul

At St. Paul the three-mile long flood barrier extends from the upper end of Harriet Island along the west bank of the river to a point northwest of Holman Municipal Airport. From that point the barrier extends inland to high ground southwest of the airport. The barrier is an earth levee with the exception of about one-half mile of noncontinuous floodwall along areas where concentrated industrial activity limits space for levees.

The project has eight stop-log closure structures and five sandbag closures to permit use of roads and railroads during periods of normal water stages. Three pumping plants and about 7,000 feet of interceptor and stormwater sewers pump out seepage and rainwater from behind the barrier.

Due to significant flooding on the Mississippi River in 1965 and 1969, the level of protection provided by the project at St. Paul was reevaluated and a plan to raise the flood barrier by four feet was recommended (See St. Paul, Mississippi River, Project Underway, Flood Control — Local Protection).

South St. Paul

At South St. Paul the flood barrier is about 2.5 miles long, consisting mainly of an earth levee with the exception of approximately one-half mile of floodwall. The project extends from above Wentworth Avenue past the packing plants and stockyards and around the sewage plant to high ground at the railroad track. Three stop-log closure structures and one sandbag closure permit normal access through the levee. Two pumping plants and about 7,300 feet of interceptor and stormwater sewers provide drainage. The Corps completed the work in 1968.

The levees and floodwall at St. Paul are about 2.4 feet higher than the all-time high flood crest of 1965. The levee and floodwall at South St. Paul are about 4 feet higher than the 1965 flood stage.

The project has prevented about $26,573,000 in damages at St. Paul and $15,881,000 at South St. Paul through September 1990. Total Federal cost of the project was $8,476,000. Local interests contributed an additional $780,100.

Winona, Mississippi River,
Completed Project
Flood Control — Local Protection
(St. Paul District)

The 1958 Flood Control Act authorized improvements at Winona consisting of a continuous flood barrier about 6.6 miles long. Under this authority, existing dikes and levees totaling 6.1 miles were raised, strengthened, and lengthened from Minnesota City along the Lock and Dam 5A dike to Prairie Island, along the Prairie Island dike to the mainland, and along the Crooked Slough levee to near Huff and Second Streets. Two pumping plants and about 5,500 feet of interceptor ditches were built to remove seepage and rainwater from behind the levees.

The previously completed portion of the project had a Federal cost of $2,147,000. Costs to local interests amounted to $170,000. The project is maintained by local interests.

Improvements authorized in 1971 under Section 201 of the Flood Control Act of 1965 consist of levee and floodwall protection, pumping stations, and associated interior drainage works. A sound floodplain management program was established to prevent unwise development of the area bordered by U.S. Highway 61 and Burns Valley and Pleasant Valley Creeks. The flood barrier and related features of the present project will prevent flooding by the Mississippi River and Burns Valley Creek in the area partially protected by the project completed in 1967.

The present improvement project was substantially completed in 1985 at a Federal cost of $30,594,000. The project was formally dedicated by the city on October 13, 1985. The entire project has prevented $33,880,000 in estimated damages through September 1990.

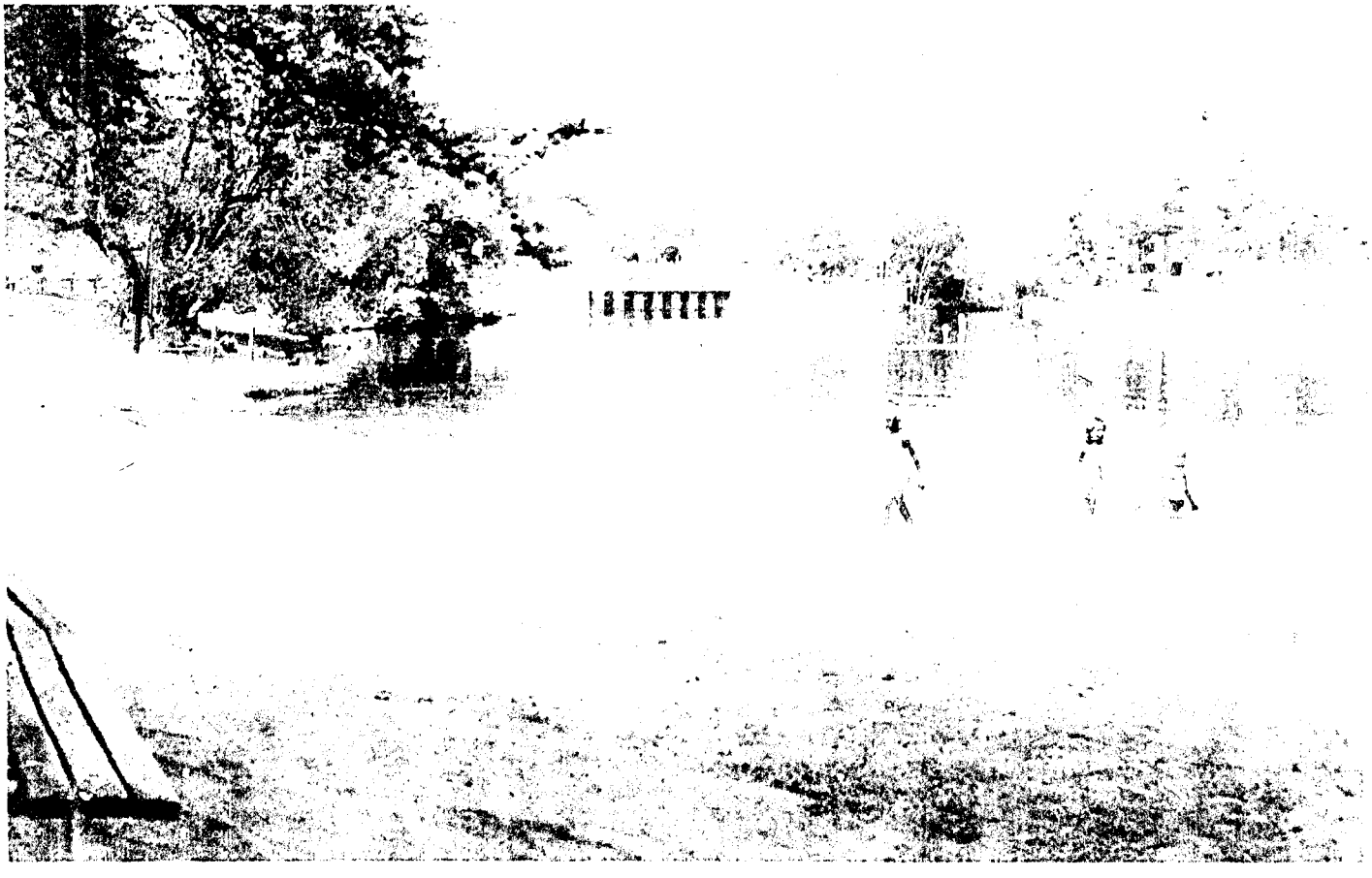
Black Bear - Miller Lakes,
Completed Project, Section 205 —
Flood Control
(St. Paul District)

Black Bear and Miller Lakes are located adjacent to the Mississippi River about 20 miles north of Brainerd, Minnesota. Prior to project construction, high water on the Mississippi River backed up the creek channel joining Black Bear Lake to the Mississippi River, flooding shoreline properties and causing damages to buildings and related facilities. Some flooding was experienced there every 3 to 5 years. The Chief of Engineers approved a project for flood control under the authority of Section 205 of the 1948 Flood Control Act, as amended. The project consists of an embankment across the creek approximately 300 feet upstream of its juncture with the Mississippi River. This structure has a culvert extending through it which can be closed off during periods of high flow on the Mississippi River. A construction contract was awarded in September 1985. The project was completed in November 1986 at a cost of $471,000.

Elk River,
Mississippi River,
Completed Project, Section 205 —
Flood Control
(St. Paul District)

The project provided a 3,400 foot riprap-protected levee on the right bank of the Mississippi River along the upstream side of a horseshoe bend near Elk River, Minnesota. Construction was completed in September 1969. Federal cost of the project was $347,578, including a modification of the construction contract in the spring of 1969 to provide emergency flood protection. Local interests contributed an estimated $25,000. The project has prevented about $949,000 in damages through September 1990.

Recreation areas developed and managed by the Corps of Engineers attract millions of visitors annually.



Hastings, Vermillion River,
Completed Project, Section 205 —
Flood Control
(St. Paul District)

The city of Hastings is located on the Mississippi River 20 miles downstream from St. Paul. The Vermillion River drains 195 square miles of central Dakota County and flows through the southwestern section of Hastings, entering the Mississippi River downstream of the city.

During the record breaking flood in the spring of 1965, Hastings residents suffered $700,000 in damages.

Following the flood, flood control measures authorized under Section 205 of the 1948 Flood Control Act, as amended, were approved for construction in 1975. The projects includes the modification of an existing dam, channel widening at two bridges, and a floodwater bypass channel paralleling the existing river channel. The St. Paul District gave full consideration to preservation and enhancement of the attractive natural river setting as well as to management of the adjacent developing areas in the floodplain. Construction of the project was completed in 1978.

Federal cost of the project was ab[illegible],000,000. Costs to local interests for land and floodplain [illegible]nagement were about $280,000.

Lake Pulaski
Completed Project, [illegible]ection 205 —
Flood Control
(St. Paul Distric[illegible])

Lake Pulaski is located in Buffalo, Minnesota, approximately 45 miles northwest of Minneapolis-St. Paul. The lake has no natural outlet. In the late 1970's and early 1980's, Lake Pulaski rose, inundating a number of houses and summer residences and threatened at least 50 more structures. The Chief of Engineers approved a project for flood control under the authority of Section 205 of the 1948 Flood Control Act as amended. A combination of a pumped pipeline and gravity-flow storm sewers to convey excess water through the city of Buffalo from Lake Pulaski to Buffalo Lake was constructed to stabilize the lake. Included in this project was a storm sewer upgrade which was constructed by the city of Buffalo. The lake will be maintained at elevation 966.0 feet mean sea level. This is the lowest level permitted for an artificial outlet under State of Minnesota rules governing landlocked lakes. A construction contract was awarded in September 1986. The project was completed in February 1987 at a cost of $1,187,500.

Okabena Creek, Worthington
Completed Project, Section 205 —
Flood Control
(Rock Island District)

The flood protection project on Okabena Creek at Worthington was approved for construction by the Chief of Engineers in 1954 under the provision of Section 205 of the 1948 Flood Control Act as amended.

The project protects Worthington from floods, primarily through the construction of levees and culverts. The project also included enlargement of the Okabena Creek channel.

Construction began in April 1955 and was completed in June of the same year at a cost of about $129,300. Federal costs were $72,400 and non-Federal costs were estimated at $56,900. The project has prevented $372,000 in damages to date.

Bassett Creek
Project Underway,
Flood Control — Local Protection
(St. Paul District)

Residential areas in the upper Bassett Creek Watershed and industrial and commercial lands in the lower watershed together with several major highways and railroads are subject to frequent flooding. A large commercial and industrial area in Minneapolis is especially susceptible because it is located immediately upstream of the 1.5 mile tunnel which serves as an outlet for the entire Bassett Creek watershed. A blockage of this deteriorating tunnel during a 100-year flood event would cause flood damages exceeding $28,100,000 in the proximity of the existing tunnel entrance.

The project, authorized by the 1976 Water Resources Development Act, consists of flood storage in the upper Bassett Creek watershed and a new tunnel in the outlet reach under a highly urbanized area of Minneapolis. Also, floodplain regulations, flood insurance, and flood forecasting and warning are included in the plan. The flood storage generally consists of providing increased temporary inundation of golf courses, parks, and open space through the watershed. The outlet tunnel is a cooperative venture with the Minnesota Department of Transportation. Construction on the downstream 6,000 feet of the tunnel has been completed. Completion and operation of the entire replacement tunnel is scheduled forearly 1992. The estimated Federal cost of the project including an estimated inflation allowance through the construction period (October 1990 price levels) is $28,200,000 and the estimated non-Federal cost is $9,400,000 of which $3,628,000 is a cash contribution.

Preconstruction planning is complete. The initial construction contract was awarded in February 1987 and total project completion is scheduled for 1993.

St. Paul, Mississippi River,
Project Underway,
Flood Control - Local Protection
(St. Paul District)

This local protection project was completed in 1964. (See St. Paul and South St. Paul, Mississippi River, Completed Project, Flood Control - Local Protection.) The flood barrier extends 3.04 miles to protect 448 floodprone acres along the Mississippi River in central St. Paul with levees, floodwalls and interior drainage works.

In 1965 and 1969, the area experienced major floods that exceeded the previous record flood in 1952. The discharge from the April 1965 flood was made up of a major contribution from the Minnesota River drainage and a lesser amount from the Mississippi River which had not crested at St. Paul. The Mississippi drainage crested less than one week later. If both rivers had concurrently contributed their maximum flows, a discharge of 211,000 cubic feet per second (cfs) would have been recorded in 1965. This would have overtopped the existing barrier by over one foot. Because of these record-breaking floods and the potential for more than $250 million in damages if the project were to fail, the existing project's level of protection must be increased.

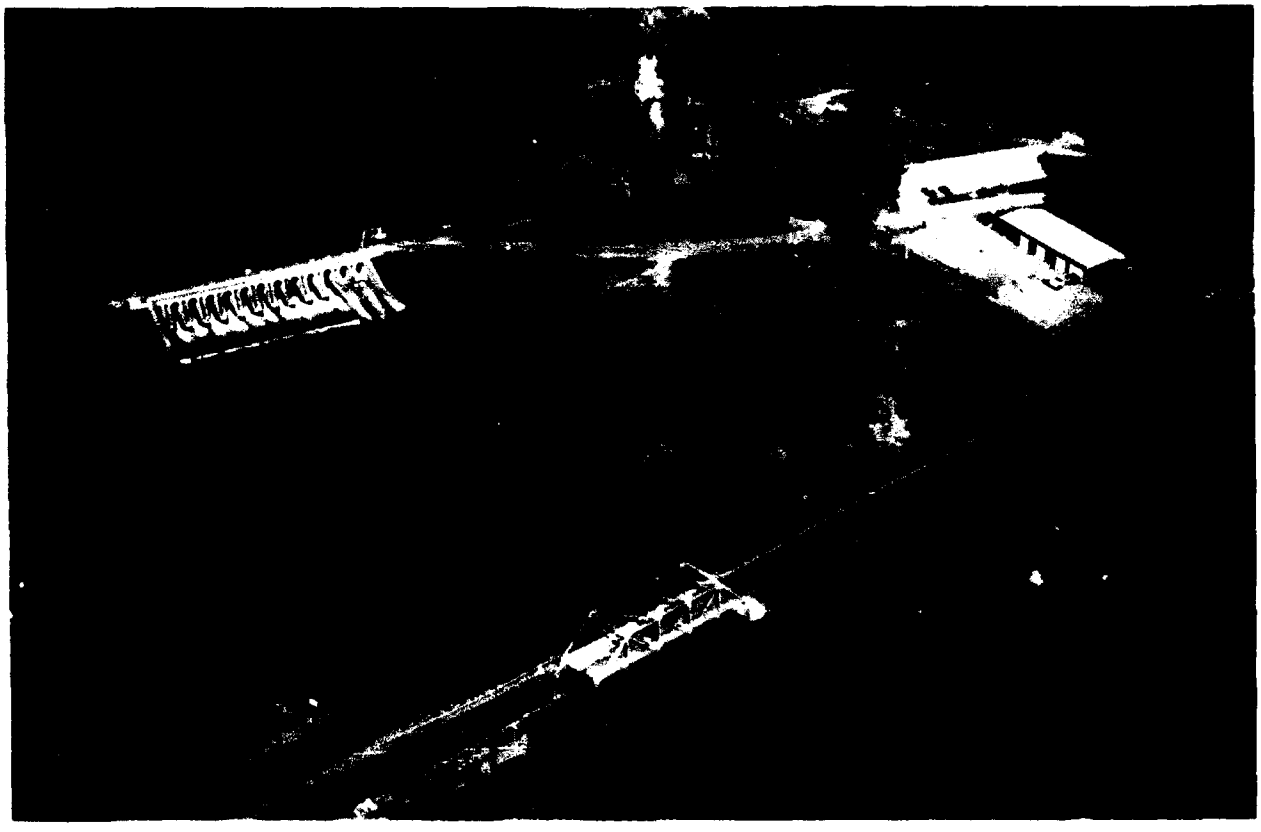
The proposed project will protect against a design flood of 210,000 cfs (588- year flood) and the top-of-barrier protects against the standard project flood of 250,000 cfs. The project was authorized for construction by the 1986 Water Resources Development Act and reauthorized in the 1990 Water Resources Development Act. The flood barrier includes 1,335 feet of floodwalls, 2,400 feet of stepped floodwalls, 12,280 feet of levees, and six closures. Three existing pumping stations will be upgraded to control interior flooding. Recreation facilities, primarily consisting of trails and walkways, have been incorporated into the project plan. Project aesthetic features have been coordinated with city of St. Paul riverfront development plans. The estimated Federal cost of the project, including an estimated inflation allowance through the construction period, (October 1990 price levels) is $11,700,000 and the estimated non-Federal cost is $8,800,000 of which $1,910,000 is a cash contribution. The first construction contract is scheduled to be awarded in 1991 and project completion is scheduled for 1994.

Iowa and Cedar Rivers, Iowa and Minnesota, Completed Study, Flood Control — Local Protection (Rock Island District)

A study of Iowa and Cedar Rivers was authorized by the resolution of the House Committee on Flood Control on July 16, 1945 and by resolution of the Senate Committee on Commerce on August 6, 1945 with later modifications. The study investigated the advisability of providing flood protection and also considered related water needs within the river basins.

In meetings conducted in 1966, the public helped to identify and discuss problems and needs. Preliminary investigations of urban and rural flood and drainage problems were completed for various locations throughout the basin. Possible alternatives to bank erosion at certain locations also were considered, and possible reservoir sites and levee plans were studied.

Under the study, three interim reports, now completed, addressed problems and needs at specific locations within the basin, none of which were in Minnesota. A final report, considering all the remaining flood problems in the river basins, was completed in fiscal year 1982.



Pine River Dam and Reservoir near Cross Lake, Minnesota.

St. Croix River, Minnesota and Wisconsin
Completed Study, Flood Control —
Local Protection
(St. Paul District)

The St. Croix River study was a study of flood problems and needs in the St. Croix River basin. The St. Croix River flows southeast for 164 miles from its source in St. Croix Lake in northwestern Wisconsin along the border between Minnesota and Wisconsin to its junction with the Mississippi River at Prescott, Wisconsin.

The initial St. Croix River feasibility study for flood control began in 1965. A preliminary report in 1968 identified a main stem reservoir as the recommended flood control alternative. However, reservoir construction would have conflicted with the Wild and Scenic River designation being considered at that time, so the study was suspended. In 1982, the study was resumed because of Congressional interest and high regional priority. As a result of the Wild and Scenic River designation, only alternatives that met the intent of the law were considered. A screening of flood-prone communities in the St. Croix River basin identified New Richmond, Wisconsin, and Stillwater, Minnesota, as the only areas appropriate for inclusion in the feasibility study. Analysis of the flood problems, collection of technical data, and development of possible flood control alternatives at the two communities were accomplished. No economically feasible flood control plan was found for Stillwater. A flood preparedness handbook was prepared to facilitate an organized, efficient flood fighting effort that would reduce future flood damages to a minimum.

At New Richmond, two feasible flood control alternatives were developed that included channel and bridge modifications, and a diversion. However, the city of New Richmond did not support either plan and no further study of the flood damage problems was pursued. The feasibility study for the St. Croix River was completed in 1986 with a recommendation of no Federal action under the St. Croix River basin study authority.

Little Falls, Study Underway,
Flood Damage Prevention
(St. Paul District)

The study area is located just upstream of Little Falls, Minnesota, where a highway crossing was constructed across the Mississippi River in 1973 by the Minnesota Department of Transportation. An embankment and bridge are located on the north edge of Little Falls in Morrison County, Minnesota. Local citizens and county representatives believe that the placement of the bridge and highway embankment across the majority of a previously free-flowing stream has caused excessive sedimentation and aquatic growth in the immediate area. Specifically,

Confluence of the St. Croix and Mississippi Rivers near Prescott, Wisconsin.

there is decreased channel capacity and water depth and increased sedimentation and aquatic growth in an area between the channel center and the eastern bank of the river from the highway bridge to about 3/4 mile downstream. There is concern that these conditions may cause flooding problems and damage adjacent property.

A Corps of Engineers field review of the problem area was conducted in 1985 and a short report was prepared to assess the problems and needs for further action. That short report recommended the need for further study, including hydraulic and sedimentation modeling to be conducted on the study area. A reconnaissance study was initiated in 1991 and is currently underway.

Crooked Slough Harbor at Winona, Mississippi River
Completed Project — Commercial Navigation
(St. Paul District)

Crooked Slough Harbor, a part of the Upper Mississippi River 9-Foot Channel Project, is a channel about 6,000 feet long, 200 feet wide, and 9 feet deep designed for the use of commercial interests at the upstream end of Winona. The project was completed in October 1956 at a Federal cost of $84,700. Non-Federal costs were about $108,000, including $2,000 in funds contributed to the cost of construction. Commercial traffic at Winona consists primarily of petroleum products and coal.

Minneapolis Harbor Below St. Anthony Falls, Mississippi River,
Completed Project — Commercial Navigation
(St. Paul District)

This commercial harbor upstream from the Washington Avenue Bridge opposite the University of Minnesota, was completed in 1932 at a cost of $192,800. As part of the Upper Mississippi River 9-Foot Channel Project, the improvement provides a turning basin 1,600 feet long and from 420 feet to 530 feet wide between the Washington Avenue Bridge and the lower Northern Pacific Bridge. The excavated material was placed on a terrace and used by the city of Minneapolis as a terminal site.

Commercial traffic at Minneapolis has averaged 1,557,670 tons per year over the past ten years and increased from about 110,000 tons in 1935 to a peak of 3,177,355 tons in 1975. Traffic in 1989 amounted to 1,522,622 tons. Since 1964 commerce for the Upper Harbor project has been included in these tonnages.

Major commodities include metals, sand and gravel, coal and building cement. (Also see St. Anthony Falls Upper Harbor Project, Mississippi River, Minneapolis, Completed Project — Commercial Navigation.)

Reservoirs at Headwaters of Mississippi River, Completed Project — Commercial Navigation
(St. Paul District)

The Corps of Engineers completed the Mississippi River Headwaters Reservoirs project in 1937 to augment flows in the Mississippi River for navigation. The project, authorized by the 1899 River and Harbor Act with later modifications, provided for reconstruction from timber to concrete at Winnibigoshish, Leech Lake, Pokegama, Sandy Lake and Pine River Dams, and construction of a concrete dam at Gull Lake. Pokegama was built on bedrock and the others on pile foundations. A portion of Leech Lake Dam from piers 26 to 39 was replaced with an earth fill. Three dikes were constructed at Winnibigoshish, four at Pokegama, two at Sandy Lake, and 16 at Pine River. Sandy Lake Dam includes a lock 160 feet long, 30 feet wide, with a maximum lift of 9.5 feet and a depth of 2.5 feet on lower sill at low water which was converted to use as a spillway. None of the other dams have locks and there is no commercial traffic in the area.

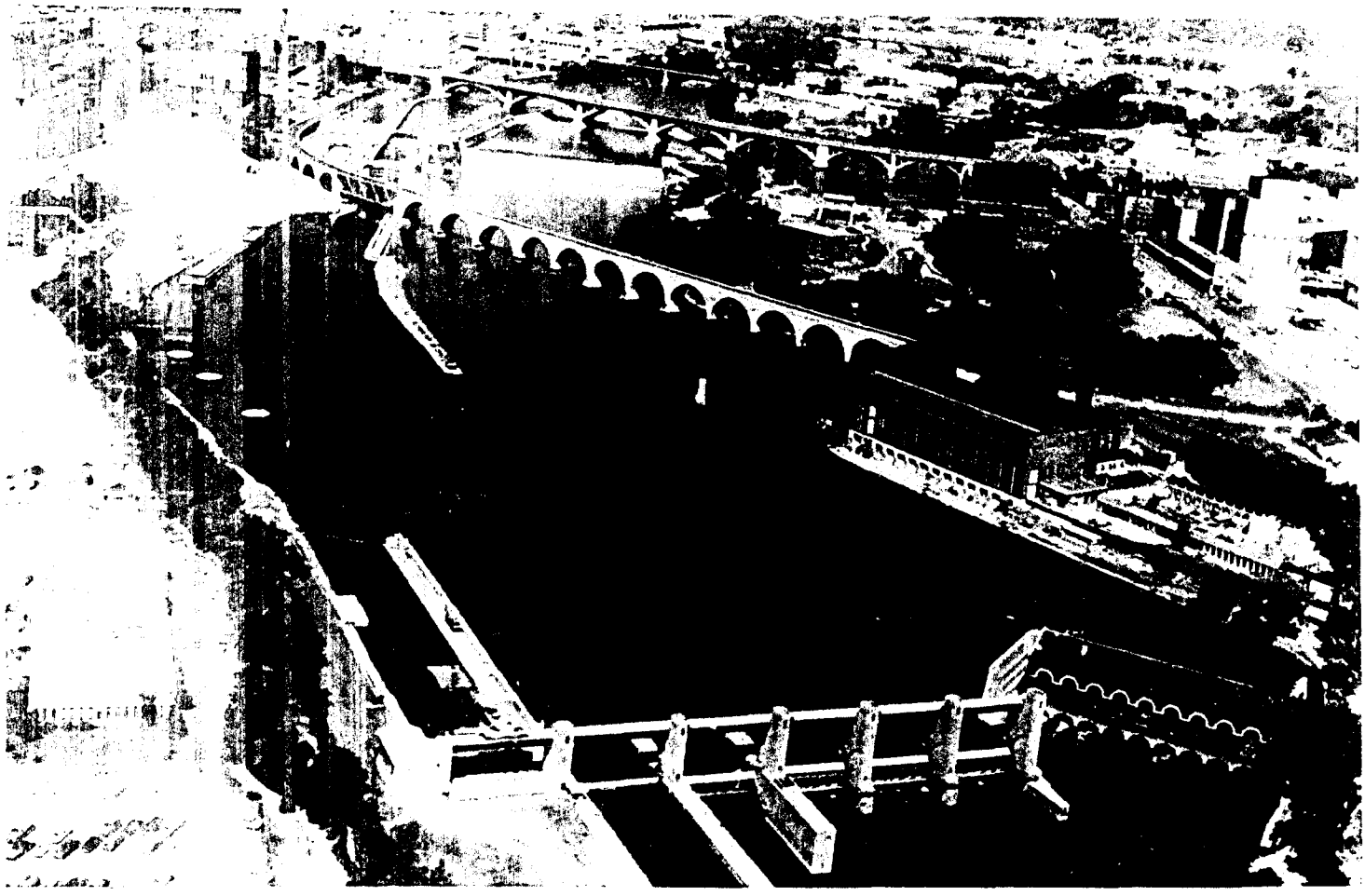
Although they were authorized primarily for navigation, the reservoirs operate, whenever possible, to reduce flood stages in the vicinity of Aitkin and to facilitate use of the area for recreational purposes and fish and wildlife conservation. The reservoirs are in the heart of a very popular resort area and provided over 28,700,000 recreation visitor hours of use during 1990.

On Gull, Leech, Sandy, Pokegama and Winnibigoshish Lakes, and at Pine River Lake, the Corps has placed facilities for swimming, boat launching, camping, picnicking and sanitation. Most facilities are designed for handicapped use. Areas also have been made available to State and local interests for recreational purposes. The regulated outflow from the reservoirs contributes to improved water supply, pollution abatement and industrial development, particularly in the section of the river between Grand Rapids and the Twin Cities.

The average annual maintenance cost for the past 5 years was about $2,219,372. (Also see Reservoirs at Headwaters of Mississippi River, Completed Study — Commercial Navigation.)

St. Anthony Falls Upper Harbor Project, Mississippi River, Minneapolis, Completed Project — Commercial Navigation
(St. Paul District)

Extension of the 9-foot channel of the Mississippi River at Minneapolis from the site of the lower Northern Pacific Railway Bridge for a distance of 4.6 miles upstream to the Soo Line Railway Bridge was a modification of the Upper Mississippi



Upper and lower locks at St. Anthony Falls.

River 9-Foot Channel Project. It enabled modern barges, towboats and pleasure craft to ascend the Falls of St. Anthony some 75 feet into the center of Minneapolis.

The improvement provided a lower lock and dam; an upper lock through an existing dam at the Falls; dredging below the lower lock, between the locks and upstream from the upper lock; a turning basin near the upper limit of the project near 41st Avenue North; and bridge and utility alterations.

The locks are 56 feet wide and 400 feet long, the lower lock having a lift of 25 feet and the upper lock a lift of 49.2 feet. The dredged channel provided a 9-foot depth and widths of from 100 to 400 feet. A turning basin at the upstream end is 500 feet wide. The lower lock and dam was completed in 1956, the upper lock was opened to navigation in 1963, and the entire project was completed in 1967.

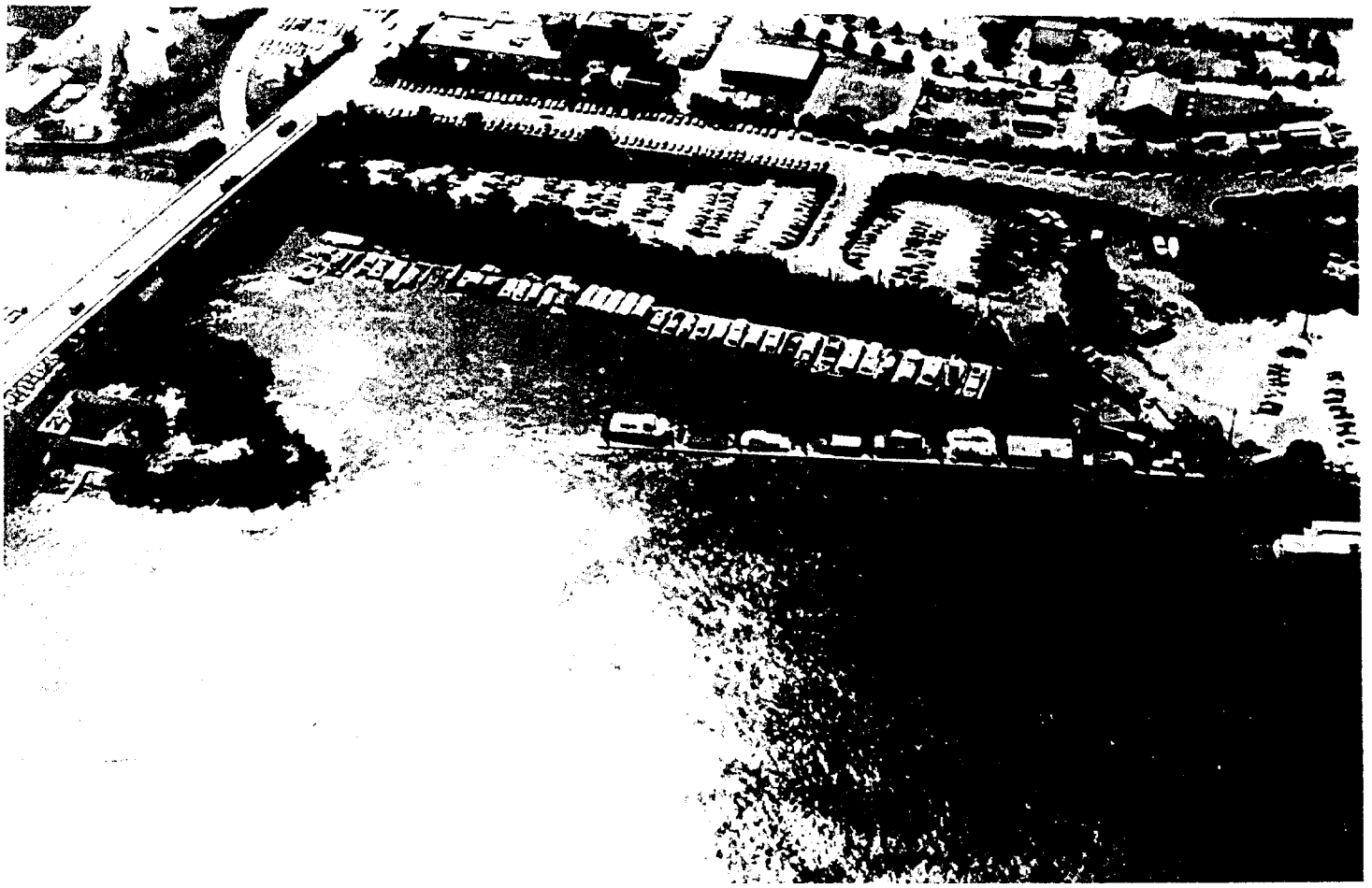
The project required alteration of the Great Northern Railroad bridges, where truss spans replace the former deep-girder channel spans.

The city of Minneapolis raised or rebuilt three highway bridges to provide sufficient clearance for the towboats. Total construction cost was $31,690,000 including $1,100,000 contributed by local interests.

Additional costs incurred by the city, not included in the above but contributing toward the project as a whole, were: lands, $500,000; relocation of bridges and utilities, $1,770,000; and additions and betterments to revetments and dockage facilities, over $3,000,000. (See also Minneapolis Harbor Below St. Anthony Falls, Mississippi River, Completed Project — Commercial Navigation.)

St. Croix River, Wisconsin and Minnesota, Completed Project — Commercial Navigation
(St. Paul District)

The St. Croix River navigation project, originally authorized on June 18, 1878 with later modifications, provided for a channel 9 feet deep for 24 1/2 miles from the mouth of the St. Croix River at Prescott, Wisconsin to Stillwater Minnesota; a channel three feet deep between Stillwater and Taylors Falls, Minnesota; and the improvement of the harbor and waterfront at Stillwater.



St. Paul small-boat harbor.

Commercial traffic at Stillwater amounted to only 22,300 tons in 1989. Coal that had been previously transported by barge was shipped primarily by rail. There is also recreational small-boat traffic from the mouth of the river to Taylors Falls. From Stillwater to Taylors Falls the controlling depth is about one foot at extreme low water. This reach is used extensively by campers and canoeists.

St. Paul District completed the existing St. Croix navigation project in 1930 at a cost of $150,400. Maintenance costs since the project was authorized total $1,178,055 through September 1990.

St. Paul Harbors, Mississippi River
Completed Project — Commercial
and Recreational Navigation
(St. Paul District)

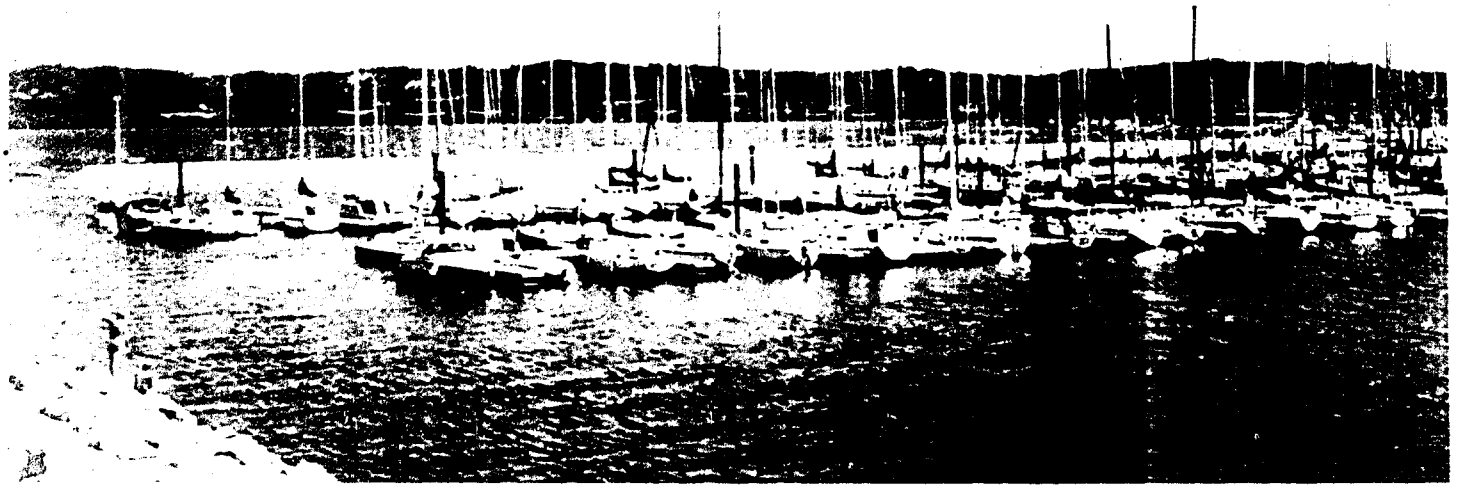
The harbor development at St. Paul is part of the Upper Mississippi River 9- Foot Channel Project. Congress authorized the work in two separate actions. The earlier authorization provided for deepening and widening the channel below Robert Street and placing the excavated material along the left bank of the Mississippi River from Sibley Street to the Municipal Barge Terminal. The material then was used by the city for a roadway. This work was completed in 1937 at a cost of approximately $217,000 to the United States and $40,000 to local interests.

The later authorization provided for enlarging the flood capacity in the main channel between Smith Avenue Bridge and State Street by dredging to a 9-foot depth to reduce velocities in that section of the river during high water periods. It included a 5-foot deep small-boat harbor dredged at the foot of Harriet Island providing a haven for 150 recreational craft. The second phase of the project also provided for placing the excavated material along the left bank of the Mississippi River between Market Street and Lambert Landing, which also was developed as a roadway by the city of St. Paul. This portion of the St. Paul Harbors project was completed in December 1949 at a cost of about $230,200 to the Federal Government and $41,200 to local interests.

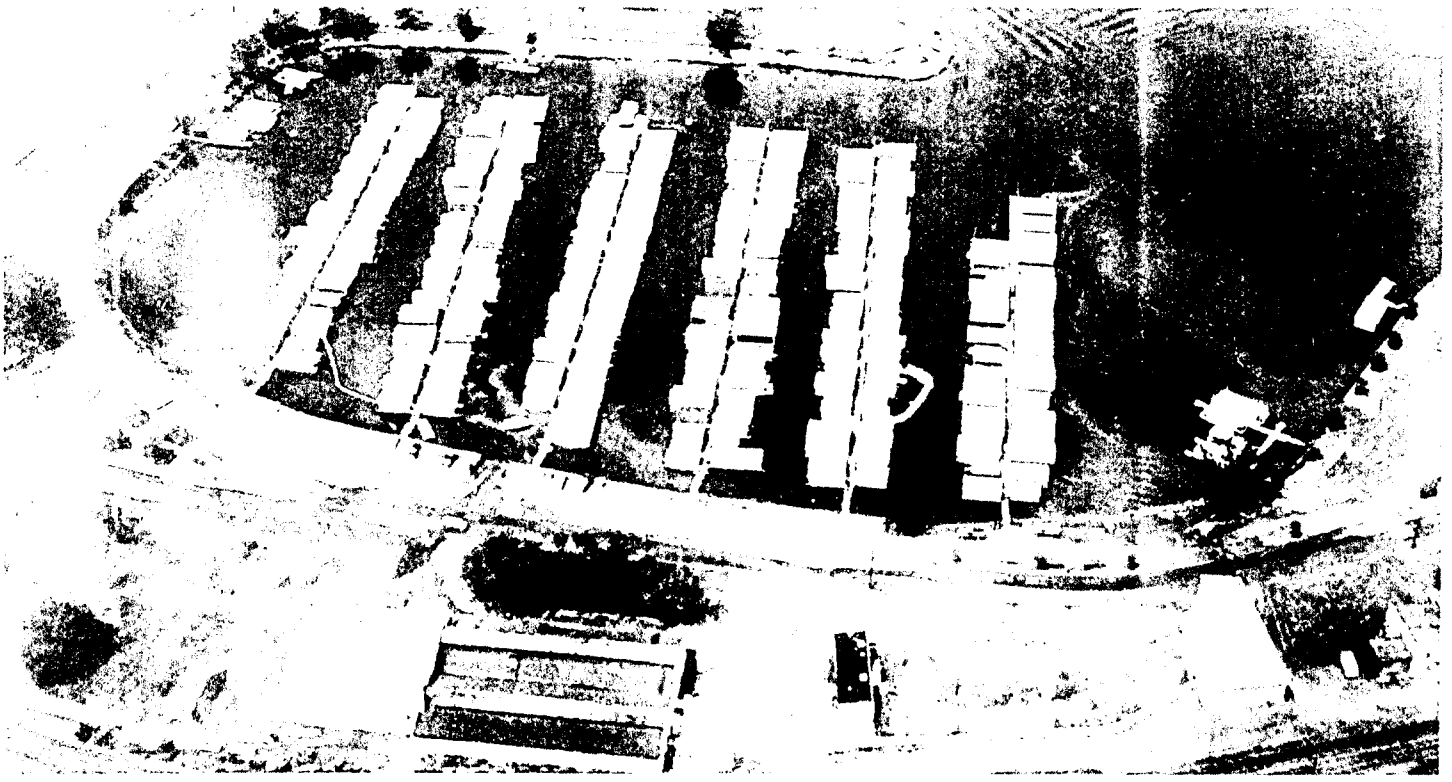
Commercial traffic at St. Paul averaged about 9,296,006 tons per year for the past ten years. It increased from 68,160 tons in 1935 to a peak of 12,535,034 tons in 1984. Traffic in 1989 amounted to 6,289,835 tons. Major commodities handled included grain, sand and gravel, coal, and petroleum products.

Lake City Harbors, Mississippi River,
Completed Project — Commercial
and Recreational Navigation
(St. Paul District)

This improvement, a part of the Upper Mississippi River 9-Foot Channel Project, included a commercial harbor, 1,000 feet



Lake City small-boat harbor.



Red Wing small-boat harbor.

long by 500 feet wide by 10 feet deep, and a connecting small-boat harbor of about six acres with 5-foot depth. Located on beautiful Lake Pepin, the project is in an area of extensive year-round recreational use. The harbors were completed in 1948 at a cost of $93,500. Local interests have completed improvements of the small-boat harbor. There has been no commercial traffic in recent years. Construction was completed in 1984 on a project which converted the commercial harbor into a small-boat harbor. (See Lake City Harbor, Mississippi River, Completed Project, Section 107 — Recreational Navigation.)

Red Wing Harbors, Mississippi River,
Completed Project — Commercial and Recreational Navigation
(St. Paul District)

Red Wing Harbor, completed in 1947, was the first of eight small-boat harbors built in the Minnesota-Wisconsin-Iowa reach of the Mississippi River. The harbor, a part of the Upper Mississippi River 9-Foot Channel Project, measures 450 feet by 800 feet and has a 5-foot depth. Federal construction costs were $8,700.

The 1950 River and Harbor Act authorized the enlargement of the commercial harbor at Red Wing by dredging a basin averaging 300 feet wide and 1,200 feet long to a depth of 9 feet in an area west of the already existing industrial harbor. The project, completed in August 1962, relieved the congestion in the terminal and reduced the hazard to boats using the small-boat harbor. Traffic at the terminal has increased steadily. Commerce consists primarily of the receipt of coal and shipment of grain. The total Federal cost of the work was approximately $146,800 and the cost to local interests was about $58,000, including over $3,000 in funds contributed by the city of Red Wing.

Mississippi River between the Missouri River and Minneapolis, 9-Foot Channel Project,
Project Underway — Commercial Navigation
(St. Paul, Rock Island and St. Louis Districts)

The Mississippi River between the Missouri River and Minneapolis, Minnesota, has been improved for navigation by a system of locks and dams at 28 locations. These locks and dams have changed the river into a series of "steps" which river tows and other boats either "climb" or "descend" as they travel upstream or downstream.

The lowermost dam in the 9-Foot Project, No. 26, is located at Alton, Illinois, just above the mouth of the Missouri River, and the uppermost dam, (St. Anthony Falls) at Minneapolis, Minnesota, is 853.75 miles above the Ohio River.

Another dam, No. 27, is located just below the mouth of the Missouri River at Granite City, Illinois. This dam, Chain of Rocks Canal and Locks No. 27, completes the series of locks and dams on the Upper Mississippi. It was completed under a separate authorization. The dams are spaced at irregular intervals varying from 9.6 to 46.3 miles, the average length of pools being 25 miles. The lift of the locks varies from 5.5 to 49.2 feet with an average lift of 12.9 feet.

At most of the sites a main lock 110 x 600 feet has been constructed, together with the upper gate bay of an auxiliary lock 110 x 360 feet to be completed when required by traffic. Replacement of Locks and Dam 26 is under construction.

Exceptions are as follows:

St. Anthony Falls Upper Lock — Single Lock 56 x 400 feet

St. Anthony Falls Lower Lock — Single Lock 56 x 400 feet and upper gate bay of an auxiliary lock

Locks No. 1 — Twin locks 56 x 400 feet

Locks No. 2 — Old lock 110 x 500 feet; new lock 110 x 600 feet

Locks No. 14 — Single lock 110 x 600 feet; old LeClaire Canal Lock 80 x 320 feet

Locks No. 15 — Main lock 110 x 600 feet; auxiliary lock 110 x 360 feet

Lock No. 19 — Main lock 110 x 1,200 feet

Locks No.26 — Main lock 110 x 600 feet; old lock 110 x 360 feet

New Locks No. 26 — Main lock 110 x 1,200 feet; 2nd lock 110 x 600 feet

Lock No. 27 — Main lock 110 x 1,200 feet

Authorized in the River and Harbor Act of July 3, 1930, the Upper Mississippi River Nine-Foot Channel Project, with the exception of the upper 4.6 miles (St. Anthony Falls extension) has been in operation since 1940. The latter project was placed in operation on September 21, 1963. Improvements to the navigation channel near Rock Island, Illinois were made from 1967 through 1971 and 1986 through 1989. Sharp rock ledges and displaced rock on the channel bottom which created hazards to navigation were removed to widen and deepen and, in some places, realign the channel.

Federal expenditures for new work to September 30, 1990 were $945,754,906 (including costs from inception).

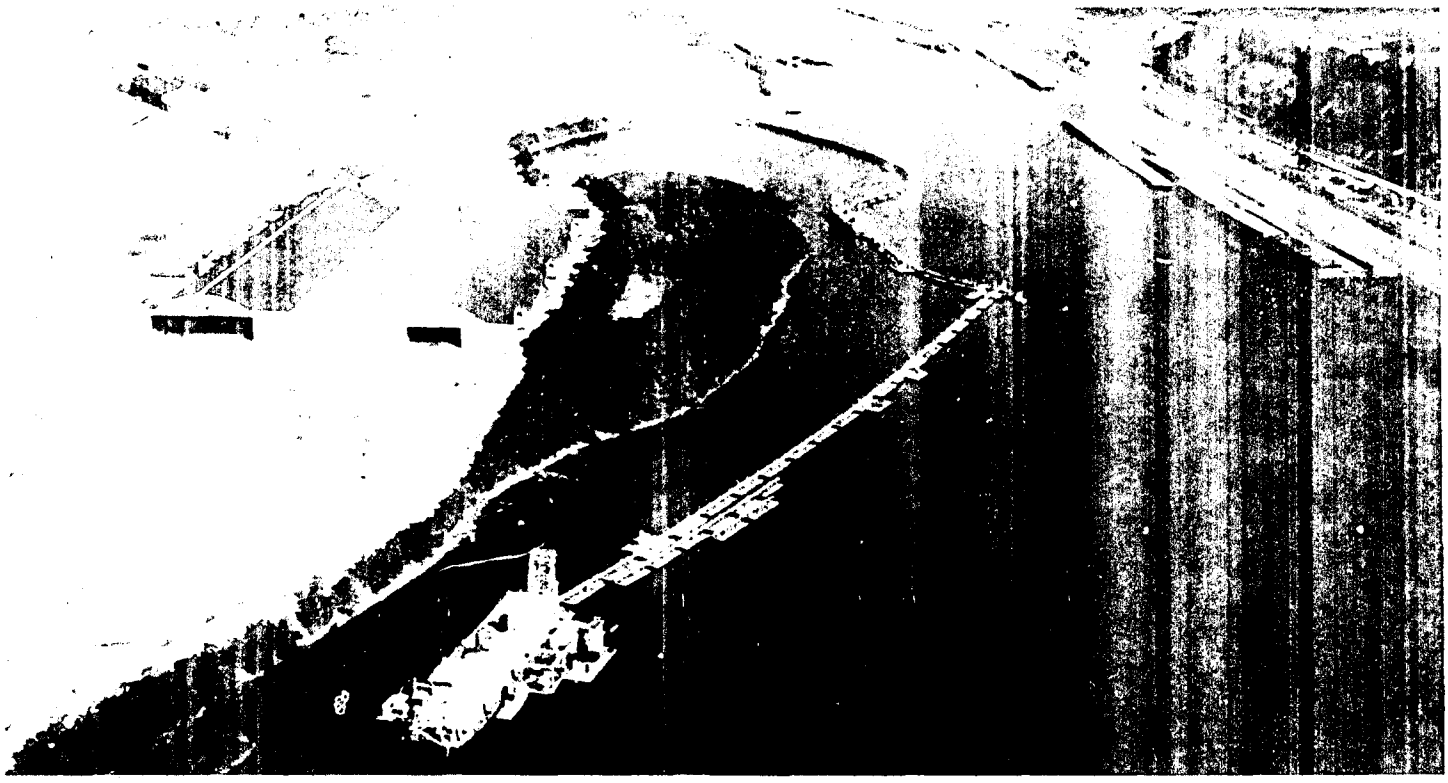
The cost of maintenance in fiscal year 1990 was $69,715,421.

Commercial Traffic

River traffic has increased rapidly since completion of the principal features of the project. Commercial navigation traffic on the 9-Foot Channel Project increased from 2,410,000 tons in 1939 to 79,351,270 tons in 1989. Principal commodities transported are petroleum products, coal, and grain, although in recent years tonnage has become more diversified with substantial quantities of iron and steel, chemicals, and other products being moved. See following table.

Commodity Breakdown, Mississippi River Above Mouth of Missouri River 1989

Commodity	Short Tons (000's)
Farm Products	36,106
Fresh Fish and Other Marine Products	15



U.S. Army Corps of Engineers dredge THOMPSON operating on the Mississippi River — periodic dredging is necessary to maintain a 9-foot channel depth for commercial barge traffic.

Locking through Lock and Dam 2, Hastings, Minnesota.

Metallic Ores	432
Coal	9,605
Crude Petroleum	90
Nonmetallic Minerals, Except Fuels	4,650
Food and Kindred Products	5,948
Basic Textiles	12
Lumber and Wood Products, Except Furniture	32
Pulp, Paper and Allied Products	8
Chemicals and Allied Products	6,970
Petroleum and Coal Products	10,464
Stone, Clay, Glass and Concrete Products	1,897
Primary Metal Products	1,672
Fabricated Metal Products, Except Ordnance, Machinery and Transportation Equipment	182
Machinery	31
Waste, Scrap and Waterway Improvement Materials	1,237
TOTAL	79,351

Recreational Resources

The nine-foot channel project was originally constructed with a single purpose in mind — to provide sufficient water depth for river traffic during low flows in the river. The project, however, also provided additional benefits.

The navigation project has improved the desirability of the Upper Mississippi River for practically all types of outdoor recreation by providing more stable water levels where formerly the river fluctuated substantially with every change in flow.

Throughout the year the locks and dams now provide a series of slack-water pools which annually attract thousands of persons who fish, swim, boat, hunt or picnic. Recreational activity continues to increase with each passing season.

Resource Management

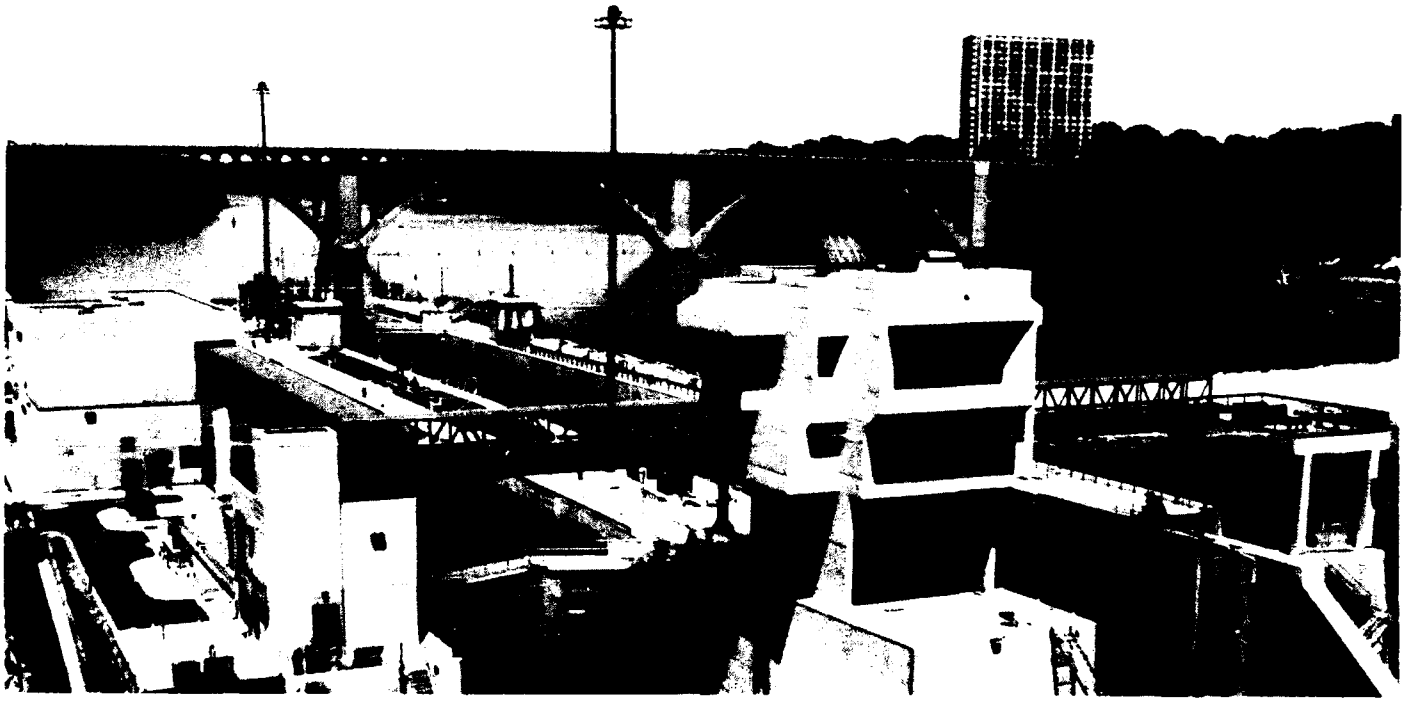
The management plan for the Upper Mississippi River pools considers the unique wild character of the river bottomlands and the desirability of preserving their wildlife resources. Most of the lands acquired for the navigation project have been made available for concurrent administration by the U.S. Fish and Wildlife Service for waterfowl management. The lands acquired by the Federal Government for construction of the Nine-Foot Channel Project are managed to serve the general public, and many recreational opportunities are available as the result of the present navigation system. Generally, except for areas which are posted as waterfowl sanctuaries, these same lands may be used for wilderness camping and other recreational activities. All other Federal lands not leased or licensed for special purposes are also open to the public.

Public Use Facilities

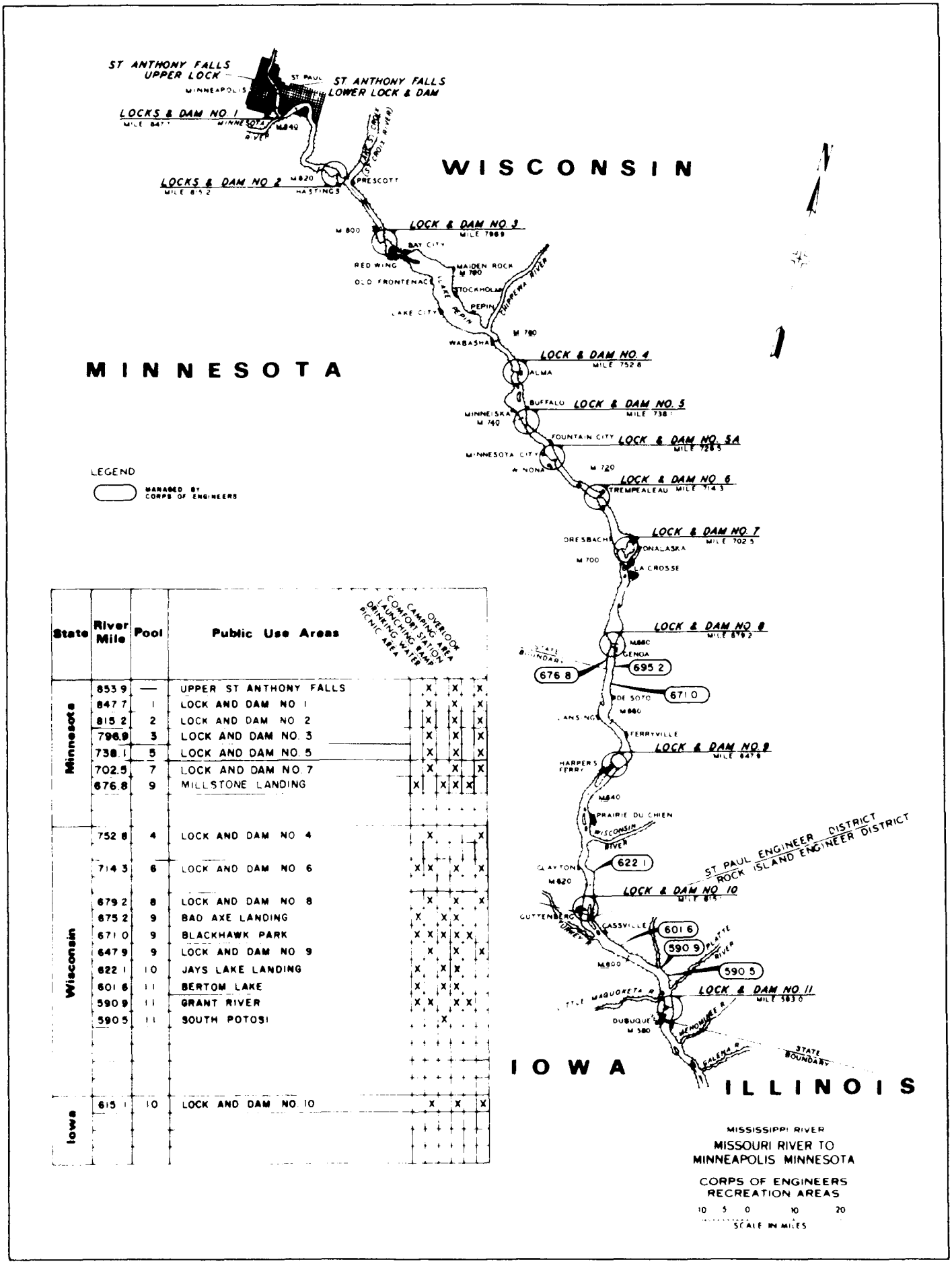
The Corps of Engineers operates many public-use areas along the 9-foot channel project. These range in size from 1 to 75 acres. The degree of development ranges from day-use areas with boat launching, picnicking and parking facilities, to areas developed with camping facilities. In addition, there are a number of public-use areas on Corps land which have been developed and are operated by other agencies.

Locks and dams of the project attract many sightseers. Visitors always are welcome at the locks and dams. Observation platforms have been provided at many of the locks so that visitors may have a better and safer view of the lock operations.

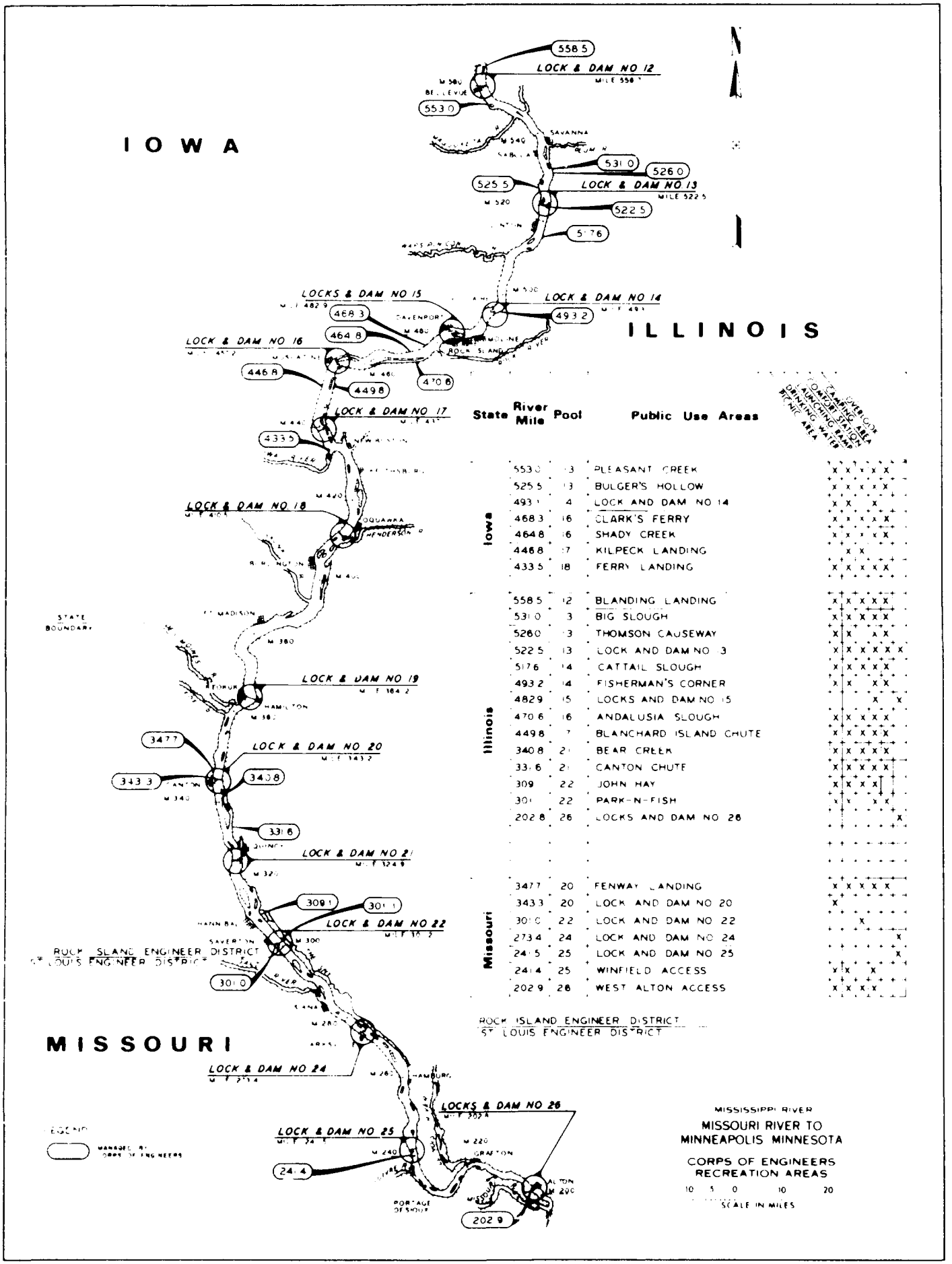
Charts at the end of this narrative show the location and type of public-use facilities provided by the Corps of Engineers along the 9-foot channel project. More detailed information on specific public-use areas may be obtained by contacting the



Major rehabilitation was recently completed at Lock and Dam No. 1, Minneapolis, Minnesota. Rehabilitation of the locks will extend the design life of the structure an additional 50 years.



State	River Mile	Pool	Public Use Areas	Overlook	Camping Area	Comfort Station	Launching Ramp	Drinking Water	Picnic Area
Minnesota	853.9	—	UPPER ST ANTHONY FALLS	X		X		X	X
	847.7	1	LOCK AND DAM NO 1	X		X		X	X
	815.2	2	LOCK AND DAM NO 2	X		X		X	X
	796.9	3	LOCK AND DAM NO. 3	X		X		X	X
	738.1	5	LOCK AND DAM NO. 5	X		X		X	X
	702.5	7	LOCK AND DAM NO 7	X		X		X	X
	676.8	9	MILLSTONE LANDING	X	X	X	X	X	X
Wisconsin	752.8	4	LOCK AND DAM NO 4	X		X			X
	714.3	6	LOCK AND DAM NO 6	X	X	X		X	X
	679.2	8	LOCK AND DAM NO 8	X		X		X	X
	675.2	9	BAD AXE LANDING	X	X	X		X	X
	671.0	9	BLACKHAWK PARK	X	X	X	X	X	X
	647.9	9	LOCK AND DAM NO 9	X		X		X	X
	622.1	10	JAYS LAKE LANDING	X	X	X			
	601.6	11	BERTOM LAKE	X		X		X	
	590.9	11	GRANT RIVER	X	X	X	X	X	X
	590.5	11	SOUTH POTOSI	X		X			
Iowa	615.1	10	LOCK AND DAM NO 10	X		X		X	X



	State	River Mile	Pool	Public Use Areas
	Iowa	5530	13	PLEASANT CREEK
		5255	13	BULGER'S HOLLOW
		4931	4	LOCK AND DAM NO 14
		4683	16	CLARK'S FERRY
		4648	16	SHADY CREEK
		4468	17	KILPECK LANDING
		4335	18	FERRY LANDING
	Illinois	5585	12	BLANDING LANDING
		5310	13	BIG SLOUGH
		5260	13	THOMSON CAUSEWAY
		5225	13	LOCK AND DAM NO 13
		5176	14	CATTAIL SLOUGH
		4932	14	FISHERMAN'S CORNER
		4829	15	LOCKS AND DAM NO 15
		4706	16	ANDALUSIA SLOUGH
		4498	17	BLANCHARD ISLAND CHUTE
		3408	21	BEAR CREEK
		3316	21	CANTON CHUTE
		309	22	JOHN HAY
		301	22	PARK-N-FISH
		2028	26	LOCKS AND DAM NO 26
	Missouri	3477	20	FENWAY LANDING
		3433	20	LOCK AND DAM NO 20
		3010	22	LOCK AND DAM NO 22
		2734	24	LOCK AND DAM NO 24
		2415	25	LOCK AND DAM NO 25
		2414	25	WINFIELD ACCESS
		2029	26	WEST ALTON ACCESS

ROCK ISLAND ENGINEER DISTRICT
ST LOUIS ENGINEER DISTRICT

appropriate District Commander at St. Paul, Rock Island, and St. Louis District office addresses found in the "Foreword" to this pamphlet.

Navigation charts, on sale in Corps District offices and at some boat docks and marinas, show Federally-owned lands under the jurisdiction of the Corps of Engineers and the U.S. Fish and Wildlife Service, the road network leading to the river, river access points, facilities available at these points, and commercial recreation development on both privately owned and public lands.

Lock and Dam No. 1, Mississippi River,
Completed Project,
Major Rehabilitation — Commercial Navigation
(St. Paul District)

This project is located at Mississippi River mile 847.6 above the mouth of the Ohio River between the cities of St. Paul and Minneapolis. The plan of improvement provided for rehabilitation of the landward lock, the riverward lock and the dam at Lock and Dam No. 1.

The original structure began operating in 1917. In 1929 the lock failed, cutting off all barge traffic in Minneapolis. Twin locks each 56 by 400 feet were constructed. The riverward lock was completed in 1930, and the landward lock in 1932. While the dam was in good condition, the locks were in need of substantial repair. History indicated that remedial measures continued to be necessary to maintain the structure. Anticipated traffic coupled with the continually deteriorating conditions of the existing locks justified the major rehabilitation work. Construction was begun in 1978 and was completed in 1983 at a cost of $44,600,000. Rehabilitation is expected to extend the design life of the structure an additional 50 years.

Locks and Dams 2-10, Mississippi River, Project Underway,
Major Rehabilitation — Commercial Navigation
(St. Paul District)

This major rehabilitation work is made up of two features-the crane carriers and bulkhead hoists at Lock and Dam 5 and stage 2 work consisting of the central control building, site work, and control system at Lock and Dam 5. The crane carrier and bulkhead hoists and the stage 2 work are complete features, including both supply and installation. The features included in this program to date include only work at Lock and Dam 5. The crane carrier and bulkhead hoists for the rest of the sites will be accomplished with operations and maintenance funds.

There will be three contracts for this project with a total estimated project cost of $7,180,000.

Locks and Dams 3, 5A - 9, Mississippi River, Project Underway,
Major Rehabilitation - Commercial Navigation
(St. Paul District)

This major rehabilitation work involves the replacement or repair of mechanical and electrical systems at locks and dams 3 and 5A through 9. Features that fall under this project are miter gate and tainter valve machinery, control systems, roller gate chains, dam machinery repair or replacement, and power distribution throughout the site. All of these features have been designed to be used system wide and have a fifty year life expectancy.

The work plan calls for between 10 to 15 major rehabilitation features being worked on each year. This work includes supply contracts, construction contracts, and engineering for contract documents. The project cost is estimated to be $38,600,000.

Reservoirs at Headwaters of Mississippi River
Completed Study — Commercial Navigation
(St. Paul District)

The purpose of the completed Headwaters Reservoirs project was to supplement low flows for navigation (See Reservoirs at Headwaters of Mississippi River, Completed Project - Commercial Navigation). The Headwaters Reservoirs study attempted to resolve reservoir problems and identify and examine directly affected downstream problem areas. The study was completed in 1982. It was recommended that the six Mississippi River Headwaters Lakes be operated in accordance with the current plan of operation and that the current plan incorporate those conservation features identified for Winnibigoshish and Leech Lakes that are currently under an extended 5-year trial operation. The final survey report also found lack of economic justification for Federal interest in nine other problems areas and recommended that no further action be taken at this time. These nine problem areas are as follows:

—Bank erosion control on the six headwaters lakes
—Erosion problems downstream of Pokegama Dam
—White Oak Lake water levels
—Black Bear and Miller Lakes flood control (this problem was resolved under a separate authority)
—Headwaters lake perimeter dikes
—Whitefish Lakes channel obstructions and marking
—Leech Lake inlet channel restrictions
—Leech Lake Marsh channel cutoffs
—Aitkin area flood control

Small-boat harbor at Winona.

Mississippi River Navigation,
Study Underway - Commercial Navigation
(St. Paul, Rock Island, and St. Louis Districts)

The Mississippi River navigation system provides critical transportation services for our nation's heartland. The 29 locks on the Mississippi River are used to transport a variety of commodities. Grain and grain products, the largest single commodity, is shipped to the gulf for export, while coal, fertilizers, chemicals, and equipment are shipped northward for consumption in farmbelt states and associated urban areas.

The continued increase in commodity tonnage moved by barges on the Mississippi River, combined with the small lock size (600' x 110') and large barge configuration continue to cause excessive delays in varying locks on the navigation systems. The original navigation structures were designed over 50 years ago and now require studies to analyze and determine means to accommodate future traffic needs.

Authority for the UMR Navigation Study is contained in Section 216 of the Flood Control Act of 1970 (Public Law 91-611). In Fiscal Year 1990, navigation planning reconnaissance studies were undertaken for both the Mississippi River and Illinois Waterway: the Rock Island District will be responsible for Illinois Waterway study and the Upper Mississippi River study will be accomplished through the combined efforts of the St. Paul, Rock Island, and St. Louis Districts.

It will reflect a three-point management approach that has evolved over several years regarding navigation responsibilities to the waterway system. Routine operations and maintenance activities, including the addition of safety features, constitute the foundation, and first management point, upon which the Corps navigation mission is based. Routine repairs and maintenance activities keep system components safe and operational.

The second point involves the major maintenance program which began about 1986 and is expected to continue through the late 1990's. The primary purpose of this effort is to keep the existing navigation system, and its component parts, structurally sound and operational for up to 50 years. By definition, the work done under this management point is of a substantially larger scale than routine operation and maintenance (O&M).

The third, and final, point in the management approach is planning for the future. The navigation studies respond to Corps' responsibilities to formulate a strategic approach for sound capital investment planning related to our nation's inland waterways' infrastructure.

The Upper Mississippi River and the Illinois Waterway navigation studies begin the process of establishing waterway capital investment improvements. During the initial phase of planning for the future of these inland navigation systems, the Corps will collect, compile, and evaluate the engineering, economic, and environmental data necessary to make sound management decisions. Through system-wide analyses, the

Corps will identify and prioritize needs, quantify benefits for any recommended improvements and establish actions required for managing the natural resources of the system.

Both the Upper Mississippi River and the Illinois Waterway experienced a record tonnage year in 1990. As navigation traffic increases, the issues described above become more critically in need of resolution. The study efforts and findings will be detailed in separate reconnaissance reports available for public distribution in 1991.

Hastings Harbor, Mississippi River
Completed Project — Recreational Navigation
(St. Paul District)

This project, a part of the Upper Mississippi River 9-Foot Channel Project, provides a harbor 5 feet deep and from 200 to 300 feet wide by about 500 feet long at the head of Vermillion Slough, a popular fishing and boating area downstream from Hastings. The harbor was completed in June 1957 at a Federal cost of about $74,300.

Wabasha Harbor, Mississippi River
Completed Project — Recreational Navigation
(St. Paul District)

Located at the upstream end of Wabasha in a former mouth of the Zumbro River, Wabasha Harbor, a part of the Upper Mississippi River 9-Foot Channel Project, is 800 feet long, from 175 to 400 feet wide, and 5 feet deep. It was completed in 1949 at a Federal cost of $41,700.

Winona Harbor, Mississippi River
Completed Project — Recreational Navigation
(St. Paul District)

Winona Harbor, a part of the Upper Mississippi River 9-Foot Channel Project, is a small boat harbor 1,000 feet by 200 feet with a 5-foot depth located on Latsch Island across the main channel from the city of Winona. The project was completed in May 1958 at a Federal cost of about $89,800. This harbor serves the recreational boating needs of the Winona area.

Lake City Harbor, Mississippi River
Completed Project, Section 107 —
Recreational Navigation
(St. Paul District)

At the request of the City Council a reconnaissance study for a new small- boat harbor was started in 1974. The existing small-boat harbor was filled to capacity and additional harbor area was needed. The study indicated a project was potentially feasible and recommended a detailed study. A detailed project study was completed in 1982 under the authority of Section 107 of the River and Harbor Act of 1960, as amended. Construction of a navigation project was initiated in the fall of 1983 and was completed in the fall of 1984 at a Federal cost of $1,077,000. Local interests contributed $812,599. The project consists of a rock rubble breakwater which will provide a protected harbor area of about 9 acres. The breakwater includes a sidewalk on top and three fishing platforms. (See Lake City Harbors, Mississippi River, Completed Project — Commercial and Recreational Navigation.)

Andrusia Lake, Mississippi River
Completed Project, Section 14 -
Emergency Bank Protection
(St. Paul District)

The project site is located on the left bank of the Mississippi River, between Andrusia Lake and Allen's Bay of Cass Lake about 5 miles north of the city of Cass Lake, in the southeastern corner of Beltrami County, which is in north-central Minnesota.

The project to protect the streambank from erosion that is destroying a prehistoric cemetery and a historic and prehistoric habitation site was authorized under Section 14 of the 1946 Flood Control Act, as amended. The initial appraisal report, dated June 1986, recommended placing a 2-foot-thick blanket of random fill to protect the burial site from construction activities, placing granular fill and shaping 450 feet of the riverbank to a 1 vertical on 2.5 horizontal slope, and protecting the area with 9 inches of bedding and 18 inches of graded riprap. The project was approved for construction by the Chief of Engineers on October 25, 1987.

A construction contract was awarded in December 1987. The work was completed in March 1988 at a total Federal cost of $61,325. The total non-Federal cost was $20,441.

Crow River at Hanover
Completed Project, Section 14 —
Emergency Bank Protection
(St. Paul District)

The Crow River was eroding the right bank adjacent to the Hanover Dam in the city of Hanover. Located in northwest Hennepin County, Hanover is about 22 miles from Minneapolis. Hennepin County Highway 19, located on top of the bank was in danger of being lost due to continuing erosion. The project consisted of the placement of fill to reconstruct the bank and riprap protection.

In May 1986, the Chief of Engineers approved a project for repair of the erosion under provisions of Section 14 of the 1946 Flood Control Act, as amended. A construction contract was awarded in September 1986 and the project was completed in 1988 at a cost of $259,500.

Elk River, Mississippi River,
Completed Project, Section 14 —
Emergency Bank Protection
(St. Paul District)

The project, authorized by Section 14 of the 1946 Flood Control Act, provided 500 feet of riprap protection on the left bank of the Mississippi River on the southeast side of Elk River, Minnesota. The riprap protection was constructed to eliminate continued streambank erosion that was threatening a public utility. Federal cost of the project was about $54,000. The work was completed in 1977.

Shepard Road at St. Paul, Mississippi River
Completed Project, Section 14 —
Emergency Bank Protection
(St. Paul District)

The project, authorized by Section 14 of the 1946 Flood Control Act, provides for riprap bank protection along the left bank of the Mississippi River from just upstream of the Robert Street bridge to upstream of Wabasha Street bridge in St. Paul, Minnesota. Total length of the bank protection is about 1,200 linear feet. The bank protection was constructed to eliminate continued erosion which threatened Shepard Road, an important and heavily used public thoroughfare. Total Federal cost for the project was $250,000 — the upper limit of Federal participation for Section 14 projects. The city of St. Paul contributed $62,620 to the project. Construction was completed in the fall of 1984 and turned over to the city of St. Paul in January 1985.

Veterans Memorial Levee at Hastings,
Completed Project, Section 14 —
Emergency Bank Protection
(St. Paul District)

The project, authorized under Section 14 of the 1946 Flood Control Act, provided 1,100 feet of riprap protection along the right bank of the Mississippi River between the U.S. Highway 61 bridge and the Chicago, Milwaukee, St. Paul, and Pacific Railroad bridge. The bank protection was constructed to eliminate continued stream bank erosion that was threatening a historically significant park, as well as a road which is an alternate route for emergency vehicles. The Federal cost of the project was $182,000. The work was completed in 1984.

Warner Road at St. Paul, Mississippi River
Completed Project, Section 14 —
Emergency Bank Protection
(St. Paul District)

The project, authorized by Section 14 of the 1946 Flood Control Act, provides for repair of the existing slope protection along the left bank of the Mississippi River in St. Paul, Minnesota. The repair consisted of 7,660 cubic yards of graded rock fill placed along a 350-foot reach. A construction contract was awarded in December 1985 and the project was completed in the fall of 1986 at a Federal cost of about $250,000.

West Fork Des Moines River, Petersburg Township,
Completed Project, Section 14 —
Emergency Bank Protection
(Rock Island District)

The right bank of the West Fork Des Moines River, about 4 miles southeast of Jackson, Minnesota, had eroded and threatened Township Road No. 131 and Bridge No. 32527.

The Corps investigated the problem at the request of Petersburg Township officials. A report was submitted to the Chief of Engineers in July 1987 recommending repair of the eroding bank under provisions of Section 14 of the 1946 Flood Control Act, as amended. The recommendation was approved and funds allocated to perform the work. The project was completed in October 1988 at a Federal cost of $24,705 and a non-Federal cost of $5,735.

Warner Road at Sibley Street, Mississippi River,
Project Underway, Section 14 —
Emergency Bank Protection
(St. Paul District)

The project, authorized by Section 14 of the 1946 Flood Control Act, as amended, provides for reinforcement of the existing bank protection along 510 feet of the left bank of the Mississippi River in St. Paul, Minnesota. Bank failure at this site would jeopardize a major thoroughfare serving downtown and, possibly, movement through the 9-foot commercial navigation channel. The repair will include a new sheetpile wall driven about 3 feet riverward of a failing wall. The new wall will be driven to a depth of 40 feet or refusal and secured with epoxy resin anchors. The space between the old and new walls will be filled with pervious material capped with concrete.

The estimated cost of this project is about $666,000 with the Federal cost share limited to $500,000 and the remainder the responsibility of the non-Federal sponsor, the city of St. Paul. A construction contract was awarded in May 1991.

Chapter IV

Minnesota River Basin

MINNESOTA RIVER BASIN

Minnesota River Basin

Geographic Area

The Minnesota River Basin covers a 16,770 square mile area which includes all or parts of 37 counties in Minnesota, six in South Dakota, and three in Iowa. The Little Minnesota River (headwaters of the Minnesota River) drains the eastern slope of the Dakota foothills in South Dakota, approximately 30 miles west of the Minnesota border, and flows southeasterly to Big Stone Lake. The Minnesota River flows southeasterly from Big Stone Lake to Mankato where it turns and flows in a northwesterly direction to its confluence with the Mississippi River at Minneapolis-St. Paul. Above Mankato, the tributaries from the southwest are all similar in character. Each has a well-developed drainage pattern and each descends rapidly from much higher ground. Thus, they can produce sudden high and devastating flood flows that are frequently greater than flow in the main stem of the Minnesota River. The tributaries from the north also contribute large volumes of water, but not so suddenly. Runoff from the spring snowmelt has caused major flooding in the subbasin during recent years and the potential exists for even more severe flooding in the future from either snowmelt or summer storms.

The Minnesota River main stem meanders in a valley ranging from 3/4 mile to 1 mile in width and 100 to 200 feet in depth, which was formed in the post-glacial era when it served as an outlet for glacial Lake Agassiz. The river, together with the gentle undulating topography of the basin, provides some of the most productive farmland in Minnesota.

Vegetation and Wildlife

Originally most of the basin was a vast expanse of mid and tall grass prairie with extensive land and wetland acres. The conversion of prairie and wetlands to agricultural uses has produced habitat conditions unlike those observed by early settlers. Nearly 85 percent of the land is now crop or pasture land. Native prairie exists only in small, isolated remnant patches. Forested areas along the rivers and tributaries total only about 3 percent of the basin's land area.

The predominant species of wildlife include deer, beaver, otter, mink, muskrats, various species of waterfowl and shorebirds, grouse, prairie chicken, squirrels, and rabbits. Habitat quantity and quality are the major factors which control populations. Upland game bird and mammal populations have steadily declined as agricultural activity in the basin has intensified. Croplands provide adequate food supplies but the quantity and distribution of forest and brush covers are the limiting factors.

Lake game fish include northern pike, largemouth bass, walleye, crappie, and sunfish. Quality of fish habitat has decreased somewhat with increases of erosion, siltation, and accelerated eutrophication of water bodies by nutrient rich runoff from agricultural lands.

Climate

The Minnesota River Basin has a continental climate with prevailing winds and storms from the west and southwest, producing comparatively mild and dry weather in all seasons. Occasional periods of high temperatures occur during summer when warm air pushes northward from the Gulf of Mexico.

The mean temperature for the basin during July is 74°F. and during January 13°F. The freeze-free growing season generally starts about the second week of May and ends during the first week of October. The basin area near the Iowa-Minnesota border has the longest growing season-approximately 155 days. The northernmost area of the basin in South Dakota has approximately a 130 day freeze-free period.

Although total precipitation is important, its distribution during the year is even more significant. Mean annual precipitation ranges from 31 inches at the Iowa-Minnesota border to 20 inches in the South Dakota portion of the basin. Approximately two-thirds of the annual precipitation occurs during the cropping season. Seasonal snowfall averages 32 inches in South Dakota to 48 inches in the Iowa portion of the basin, and accounts for 30 percent of total precipitation.

The drought of 1933-34 produced record low flows at Mankato on the Minnesota River of 26 cfs during January 1934, while the flood of April 1965, produced record high flows of 94,100 cfs at Mankato.

Recreation

Outdoor recreation opportunities in the basin are many and varied. Hunting and water-based activities abound in most areas of the basin. Recreation trails, golf courses, tennis courts, picnic grounds, and swimming pools are most numerous in areas closest to urban population centers.

The demand for outdoor recreation opportunities has steadily increased in the past two decades. Most water enhanced and land based facilities are deficient basin wide, and some represent important priorities for additional development. Developed miles of nature trails are less than 10 percent of future needs. Snowmobile trails and development acres for picnicking and camping represent less than 20 percent of those needed by the year 2000.

The potential for expanding recreation opportunities is excellent. The full development of this potential will depend primarily on the desire of the public to place land and water resources into recreational use, and the adequacy of funds to acquire the resources and/or provide facilities.

Population and Land Use

The basin's population characteristics and trends are similar to those of most of rural America. Over the past two decades, the total population has remained fairly stable with decreases in the rural population offset by increases in the larger urban centers. Migration of young people from farms to larger towns and cities has left a slightly older population in many rural parts of the basin. The basin population in 1980 was 489,832 of which 39 percent were urban, 40 percent were rural nonfarm and 21 percent were farm residents. Major urban areas include Mankato, New Ulm, and Fairmont.

Agriculture has dominated the basic industrial output of the basin since early settlement in the latter half of the 19th

century. About 76 percent of the basin's total acreage is cropland. The predominant type of farm in the basin is cash grain, producing corn and soybeans. Livestock farming and specialized crop farming also make significant contributions to the basin's economy. Increased production efficiency could be obtained on several million acres of crop and pastureland through additional flood prevention, improved drainage, and irrigation.

The major problems and needs in this basin include existing and future water supply and water quality problems, a need for reduction of urban and rural flood damage, resolution of conflicts between industrial development and preservation interests, needs for increased recreational opportunities, and problems concerned with lake eutrophication and with the preservation of wild, unique scenic and recreational areas.

Minnesota River Valley Basin,
Comprehensive Study Underway
(St. Paul District)

Major floods occur periodically in the Minnesota River Basin. The worst flood occurred in 1965, causing an estimated $43 million in urban and agricultural damages. In addition to flood problems, poor water quality, limited recreational opportunities, and wildlife conservation management also present problems in the basin. A comprehensive study of the basin was authorized by the 1936 Flood Control Act and several House and Senate Resolutions. Although the overall basin study was never initiated, several interim studies have been completed.

A joint Corps-Soil Conservation Service (SCS) water and related land resources interim study for the Yellow Bank, Lac qui Parle, Yellow Medicine, Redwood, and Cottonwood subbasins was authorized in 1975 by Public Law 87-639. The SCS completed a Comprehensive Basin Report in 1977 which identified 81 reservoir and channel improvement sites for further study. An alternatives study, approved in 1980, evaluated all 81 reservoir sites in the five subbasins and 121 miles of potential channel improvements in the Lac qui Parle and Yellow Medicine subbasins. It recommended 28 reservoirs and 56 miles of channel improvements be studied in more detail. As subsequent studies progressed, however, it was determined that structural measures required to solve interbasin crossover flooding were not economically feasible. The interim study was completed in 1989.

Several subbasins within the Minnesota River basin experienced significant flood damages in 1965 and 1969. These subbasins were not addressed in the joint study. Therefore, the State of Minnesota requested that reconnaissance studies be undertaken for reducing flood damages in the Pomme de Terre, Chippewa, Blue Earth and the remaining tributaries of the main stem of the Minnesota River. To date, none of the studies have been initiated.

Lac qui Parle Reservoir,
Minnesota River , Completed Project,
Flood Control — Reservoir
(St. Paul District)

The Lac qui Parle flood control project on the Minnesota River near Montevideo was substantially completed by the Works Progress Administration. Under authority of the Flood Control Act of 1936, the project was transferred from the State of Minnesota to the United States in September 1950. The works covered by the project lie along Marsh and Lac qui Parle Lakes and the Minnesota River between the head of Marsh Lake and Granite Falls, Minnesota,

They include a main dam at the outlet of Lac qui Parle Lakes designed to control the Marsh Lake Reservoir. There is also a dam and diversion channel near Watson designed to divert Chippewa River floodwaters into Lac qui Parle Reservoir.

The Corps of Engineers, in order to complete the project, improved the channel from Lac qui Parle Dam to Granite Falls and modified the Lac qui Parle and Chippewa Dam structures to secure improved operation.

The total Federal cost of the project through September 1990, including recreation facilities, is $964,873 of which about $380,000 is for acquisition of lands from the State of Minnesota.

The dams had been in operation by the State of Minnesota for several years prior to the transfer.

Public Use

In addition to the primary flood control benefits of the project, other benefits have been gained through the extensive use of the project for conservation and recreation purposes. Two picnic and fishing areas have been made available on project lands. Benefits for flood damage reduction since the project has been operated by the Corps of Engineers am ·nt to about $1,174,000 while the cost of maintenance and operation through September 1990 totaled $6,767,191. The annual cost of maintenance and operation over the past 5 years averaged $557,923.

Big Stone Lake - Whetstone River,
Completed Project, Flood Control —
Local Protection
(St. Paul District)

The 1965 Flood Control Act authorized improvements for wildlife conservation and development, flood control, and recreation. The plan provided for a dam on the Minnesota River near Odessa, Minnesota, which has created a conservation pool of 2,800 acres for wildlife purposes. Upstream improvements include construction of bank protection and related work along the lower 6-mile reach of Whetstone River in South Dakota, modification of the existing dam and silt barrier at the outlet of

Big Stone Lake, and channel improvement on the Minnesota River for 3 miles below the outlet control dam.

Construction of the reservoir is complete. Land acquired by the Federal Government for the project totaled 10,795 acres of which 10,540 acres were turned over to the Secretary of the Interior in May 1975. The area has now been officially designated by the US Fish and Wildlife Service as the Big Stone National Wildlife Refuge. Recreation facilities and a maintenance building were completed in 1976. Construction of upstream improvements on the Whetstone River was completed in October 1983. Construction of improvements on the Minnesota River was completed in 1986. Total Federal cost of the project was $12,175,000.

Mankato and North Mankato,
Completed Project, Flood Control —
Local Protection
(St. Paul District)

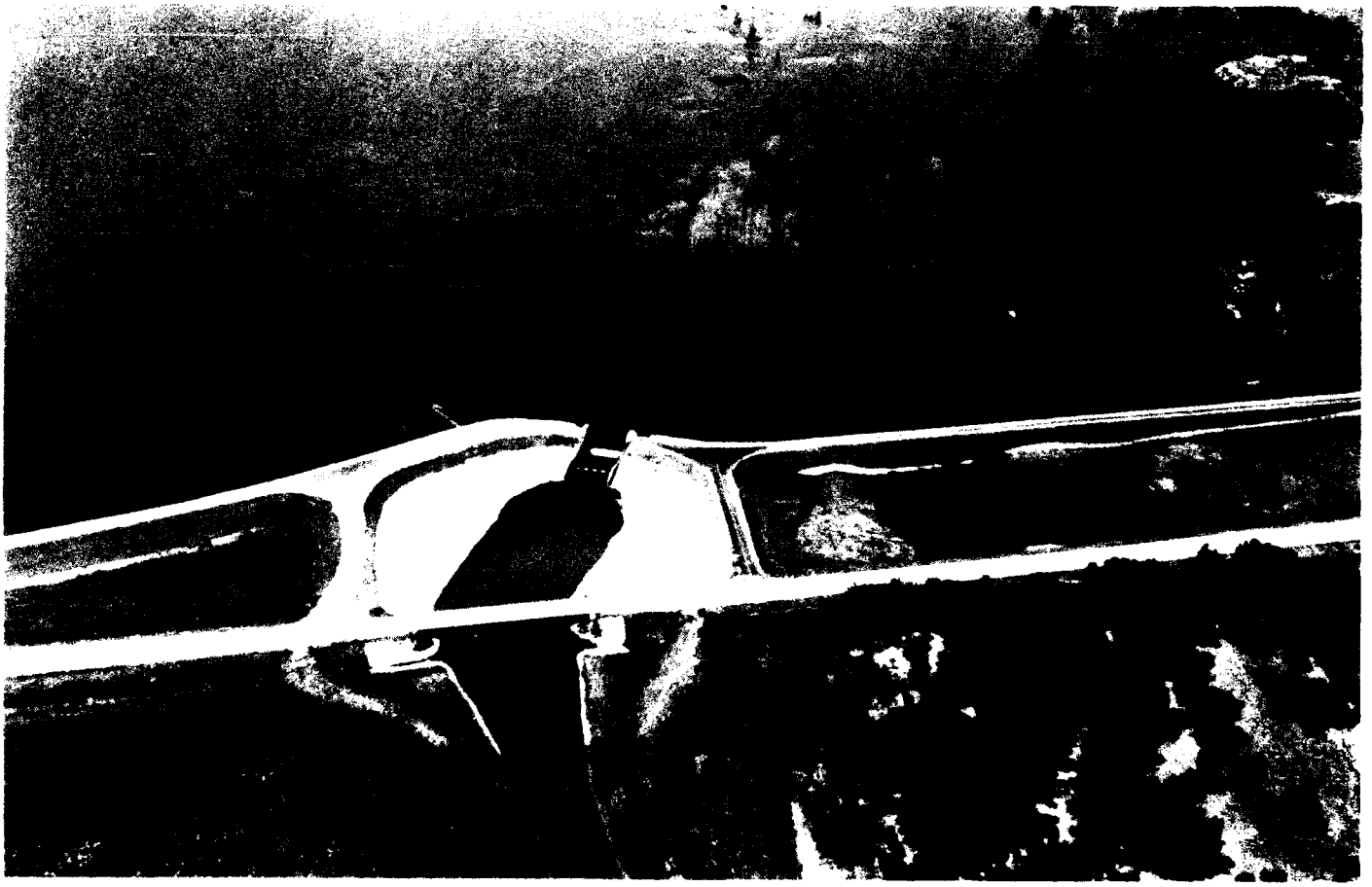
The 1958 Flood Control Act authorized improvements of the Minnesota River to protect Mankato and North Mankato from flood damage. Due to the severe 1965 flood, the project was modified to provide protection for Mankato below Warren Creek as well as for the community of Le Hillier adjacent to Mankato.

Protection features include levee, floodwalls, and interior drainage structures on both sides of the Blue Earth and Minnesota Rivers. In addition, the project includes the relocation of the twin Highway 169 bridges and the twin Chicago & Northwestern Transportation Company Railroad Bridges over the Blue Earth River and the Main Street Bridge over the Minnesota River. The 1976 Water Resources Development Act modified the authorization to include the highway bridge raises at full Federal expense.

In North Mankato, a floodwall follows along U.S. Highway 169 from the southwesterly city limits to beyond Belgrade Avenue, and a levee continues downstream to U.S. Highway 14 where the line of protection follows the highway embankment to high ground. The total length of this barrier is about 3.1 miles. Interior drainage facilities include ponding, interceptor sewers and three pumping stations.

In Mankato, the levee and floodwall extends from U.S. Highway 169 along Blue Earth River to Sibley Park and from there along the right bank of the Minnesota River to Rock Creek. Existing levees were utilized and improved whenever possible. The total length of this barrier is about 2.7 miles. Interior drainage facilities include a diversion channel, ponding, interceptor sewers, and four pumping stations.

The community of Le Hillier is protected by about 1.4 miles of levee along the left bank of the Blue Earth River and along the Chicago and Northwestern Railway track which parallels the Minnesota River. Appropriate interior drainage



Service spillway and outlet channel, Highway 75 Dam, Big Stone Lake-Whetstone River project.

Portion of levee along the Minnesota River near Mankato, Minnesota.

facilities including two pumping stations were constructed at Le Hillier.

The project was completed in 1989 at a cost of $97,270,500. Non-Federal costs amounted to about $4,350,000.

Minnesota River at Henderson
Completed Project, Section 205 —
Flood Control
(St. Paul District)

Henderson is located in the floodplain of the Minnesota River. Flooding at Henderson usually occurs during the spring due to snowmelt and rainfall contribution over the Minnesota River basin. The city has sustained flood damage during several years, the most notable being the record flood of 1965 which forced the evacuation of 95 families and caused damages in excess of $600,000 at the time. In 1969 flood damages were largely averted with the construction of an emergency levee by the Corps of Engineers under the authority of Public Law 99.

In response to a request from the city, the Corps of Engineers completed a Detailed Project Report for Flood Control at Henderson under the authority of Section 205 of the 1948 Flood Control Act, as amended. The report, completed in January 1986, recommended upgrading the existing levee to meet engineering standards for permanent levees. Included in the recommendation was the construction and reconstruction of earth fill levees over a distance of approximately 1.6 miles, with an average design height of 15 feet, structural and sandbag closures at four highway and street crossings and a confined residential area, and interior flood control facilities including two pumping stations, temporary ponding areas and interceptor storm sewers and ditches. The recommended project is designed to protect the city from a Minnesota River flood having an estimated 0.6 percent chance of occurring during any one year (170-year flood). Construction of the Henderson flood control project was initiated in May 1988 and was completed in June 1990.

Redwood River Below Marshall
Completed Project, Section 205 —
Flood Control
(St. Paul District)

Improvement of the Redwood River below Marshall to provide protection from the frequent rural flooding along the entire reach of improvement included clearing and snagging and one 900-foot cutoff from the city limits of Marshall to State Highway No. 23, a distance of about 8 river miles, and for clearing, snagging and channel straightening from State Highway No. 23 below Marshall (river mile 58.3) to river mile 20.3 in the vicinity of Seaforth, Minnesota. Work on the latter reach included excavation and straightening of the channel in 3

reaches, 15 cutoffs, and continuous clearing and snagging. Work above Highway No. 23 was completed in December 1953 and work below the highway was completed in June 1960. Total cost of the improvements was $238,500. It is estimated that because of the improvements, $388,000 in damages have been prevented through September 1990.

Yellow Medicine River at Minneota
Completed Project, Section 205 —
Flood Control
(St. Paul District)

The project, authorized by Section 205 of the 1948 Flood Control Act, as amended, provides protection from flooding of the Yellow Medicine River in the village of Minneota. Improvements included construction of a levee 2,963 feet in length; improvement of about 820 feet of channel above and below the highway and railroad crossings; a ditch about 650 feet long to divert a creek at the upper end of the levee into the river; and necessary culverts, a sewer outfall, and sandbag closures. In addition, a new highway bridge was constructed by local interests. The project was completed in May 1963 at a cost of about $161,500. It is estimated that because of the improvements, $607,000 in damages have been prevented through September 1990.

Chaska, Minnesota River
Project Underway,
Flood Control — Local Protection
(St. Paul District)

Much of the city of Chaska lies in the floodplain of the Minnesota River. A levee constructed by the city in 1952 and raised following the 1965 flood and again prior to the 1969 flood by the Corps of Engineers during Operation Foresight only partially protects the city against flooding by the Minnesota River. Chaska Creek and the East Creek which flow through the city are also subject to periodic flooding. A study was conducted to determine appropriate flood control measures for the Minnesota River at Chaska. The project, authorized by the 1976 Water Resources Development Act and modified by detailed design studies, consists of a levee and interior drainage works along the Minnesota River, flood diversion channels on Chaska Creek and East Creek and appropriate floodplain regulation measures. Principal project features include: approximately 1.1 miles of upgraded levee, 1.5 miles of new levee, and one pumping station on the Minnesota River; 1.1 miles of diversion channel on Chaska Creek; and 1.0 mile of diversion channel on East Creek. Approximately 2.9 miles of paved recreation trails on top of the levee and around Courthouse Lake are also included in the proposed plan. The estimated Federal cost of the project including an estimated inflation allowance through the construction period (October 1990) is $26,600,000 and the estimated non-Federal cost is $8,900,000 of which $2,536,000 is a cash contribution. The first construction contract was awarded in September 1988 and project completion is scheduled for 1995.

Marshall,
Project Underway, Flood Control —
Local Protection
(St. Paul District)

The 1960 Flood Control Act authorized improvements on the Redwood River at Marshall to alleviate future flood damages to the city. The project starts about 3 miles upstream of the city. It consists of a 2 1/2 mile diversion channel from northwest around the city to a junction with the main river downstream. The channel carries excess flows around the city during periods of high water.

The river was cleared of trees, brush, stumps, and debris for 3 miles from Highway 7 to the upstream end of the project southwest of town, where an earth levee a half mile long was constructed on the left bank. The channel was deepened and straightened for about one-eighth of a mile from Highway 7 to the new diversion channel. Two channel drop structures as well as four new railroad and five new highway bridges across the diversion channel were included in the project.

The improvements were designed to provide protection from a flood about 20 percent greater than the largest known flood, which occurred in June 1957. It is estimated that the project has prevented $5,308,000 in damages through September 1990. The project was completed in December 1963 at a cost of $1,803,000. The cost to local interests was about $648,000.

After the occurrence of major floods in 1957 and 1969, discharge-frequency relationships at Marshall were revised. Based on the revised discharge- frequency curve, what was originally a 114-year recurrence interval is now a 59- year interval. Because of flood problems experienced during the record April 1969 flood due to inadequate channel capacity both upstream and downstream of the existing project, the city and county requested a study to determine if corrective action is advisable.

A feasibility report was completed in July 1979. A project was authorized for construction in the 1986 Water Resources Development Act and reauthorized in the 1988 Water Resources Development Act. The recommended plan of improvement consists of channel widening, straightening, and bank reshaping measures; levees; an overflow diversion structure with appurtenant control and outlet works; interior drainage works; aesthetic measures; recreational facilities; and required relocations. The plan also includes revegetation of all disturbed areas. The plan

would provide a 133-year degree of flood protection for the city of Marshall and adjacent urbanized areas. The estimated Federal cost of the project including an estimated inflation allowance through the construction period (October 1990 prices) is $5,930,000 and the estimated non-Federal cost is $2,190,000 of which $1,262,000 is a cash contribution. Detailed design of the recommended plan is nearly complete.

Minnesota River,
Completed Project — Commercial Navigation
(St. Paul District)

The Minnesota River navigation project, authorized in 1892 and completed in 1931, provided for improvements from the river mouth at St. Paul upstream to Shakopee (25.6 miles) to obtain a channel 4 feet deep. There is considerable pleasure boating with shallow-draft vessels on the river.

In 1942 a channel 9 feet deep and 100 feet wide, except at bridges, was dredged from the mouth to Savage (13.2 miles), at the expense of local interests, so that naval tankers and towboats constructed at Savage could be taken down the river. Since then additional private terminals have been located on this reach.

In 1962 local interests improved the river between Savage and mile 21.8 to provide 9-foot depths, and in general, a width of 100 feet to serve a grain terminal at the upstream end of the improvement. Local interests have maintained the 9-foot depths intermittently.

The 1958 River and Harbor Act authorized improvements on the Minnesota River from its mouth at St. Paul to 14.7 miles upstream at a point one-half mile above the railroad bridge near Savage. This superseded that reach of the completed 4- foot depth project. Improvements under this authorization include a channel 9 feet deep and 100 feet wide, with suitable widening on bends, and with three cutoffs at approximately miles 1 1/2, 4 1/4, and 6 1/2, designed to eliminate hard-to-navigate bends in the river. Wide passages, or "turnouts", were provided to permit tows to pass each other in safety. The work was completed in 1968 at a Federal cost of $1,940,180. In addition $139,700 was contributed for dredging to a depth of 9 feet and the Minnesota Highway Department contributed $219,500 to pay for the added costs of channel realignment which will reduce costs for highway work in the future. Cost of maintenance totaled $2,722,390 through September 1990.

Commercial traffic on the river amounted to 4,371,252 tons in 1989. This traffic included shipments of corn, wheat, soybeans, fertilizers, nonmetallic minerals, and coal and lignite. Minor commodities included miscellaneous grain, petroleum, and metal products.

A study is being made to determine the feasibility of navigation above Savage. (See Minnesota River, Study Underway — Commercial Navigation.)

Minnesota River,
Study Underway — Commercial Navigation
(St. Paul District)

The purpose of this study, which was authorized in the Flood Control Act approved June 22, 1936, is to determine the need and advisability of extending the 9-foot navigation channel above mile 14.7. Public meetings were held on November 28, 1964 at New Ulm and on December 5, 1964 at Burnsville. Comments during the study were requested from the Bureau of Public Roads, Environmental Protection Agency, Public Health Service, U.S. Fish and Wildlife Service and Bureau of Outdoor Recreation, as well as State, local, and navigation interests. An additional public meeting was held at Chaska on September 25, 1969.

Local interests have requested extension on the existing 9-foot navigation channel on the Minnesota River to accommodate present and future grain traffic and provide for other projected increases in river commerce.

Status: The report was completed by the St. Paul District and forwarded to the Board of Engineers for Rivers and Harbors. Although the project was found to be economically justified, public support was lacking because of economic and environmental considerations. Thus the report was returned to the St. Paul District for further study and coordination. Resubmittal has not been scheduled at this time.

Minnesota River at Le Sueur
Completed Project, Section 14 — Emergency Bank Protection
(St. Paul District)

Le Sueur, Minnesota is located approximately 60 miles southwest of Minneapolis. The right bank of the Minnesota River was eroding for about 300 feet immediately downstream of the State Highway 93 bridge threatening a city sewer main.

In March 1985, the Chief of Engineers approved a project for repair of the erosion under provisions of Section 14 of the 1946 Flood Control Act, as amended. A construction contract awarded in August 1985 involved the excavation of all unstable channel bank material and the placement of rockfill. The project was completed in June 1986 at a total Federal cost of $250,000 and a non-Federal cost of $131,900.

Chapter V

Cannon-Zumbro-Root Rivers Basin

CANNON, ZUMBRO, & ROOT RIVERS BASIN

River Miles
Cities over 25,000
10,000 25,000
5,000 10,000
2,500 5,000
Less than 2,500
SCALE IN MILES
0 10 20 30

Cannon-Zumbro-Root Rivers Basin

The Cannon, Zumbro, and Root Rivers each share about one-third of a 4,509 square mile combined drainage area in southeastern Minnesota. The Root River and the lower portions of the Zumbro and Cannon Rivers flow generally in an easterly direction through scenic, unglaciated, deeply-incised valleys and picturesque gorges to the Mississippi River. Conversely, upland areas are characterized by gently rolling agricultural lands with wide shallow valleys. Major cities in the basin include Rochester, home of the Mayo Clinic, and Owatonna, both of which serve as trade centers for southeastern Minnesota.

The 1989 estimated population is 597,470. Rural population was 33 percent of the total in 1980.

A variety of forest and grassland wildlife are present in this basin. Wild turkeys, which were missing for many years, have been restocked in the forests of the Whitewater Wildlife Management Area and are slowly increasing. Mourning doves are plentiful but are protected from hunting. The most common big game animal is the white-tailed deer. There is also excellent waterfowl hunting in the Upper Mississippi Wildlife Refuge. Blue, snow, and Canada geese have wintered within the city of Rochester and have provided fine local attractions. The quality of the sport fishery ranges from fair to good.

Increased production efficiency could be obtained on 1,500,000 acres of crop and pastureland by 2020, through additional flood prevention, improved drainage and irrigation.

Current water and related land resource needs of the basin include flood damage reduction, water quality control, recreation, and fish and wildlife enhancement. Flooding is currently the most serious water resource problem as it has occurred almost every year at some point in the basin. Rochester suffered an estimated $54 million in damages during the catastrophic flood of July 1978. Water quality problems can occur on each of the three rivers as they pass urban areas during low flow periods. Such problems would have an adverse effect on the already limited fishing operations in the Cannon and Zumbro watersheds. The need also exists to protect an important trout fishery in the Root River watershed.

Root River and Rush Creek at Rushford,
Completed Project, Flood Control —
Local Protection
(St. Paul District)

Protection from floods from Root River and Rush Creek at Rushford was authorized by the 1958 Flood Control Act. Construction was started in June 1967 and completed in 1969. The Root River was realigned and Rush Creek was deepened. The project included construction of almost two miles of levee on the left bank of the Root River and right bank of Rush Creek to protect the principal commercial and residential areas; a levee about three-quarters of a mile long on the left bank of Rush Creek around the residential area to the east; and a levee about one-half mile long ~~and a~~ 470-foot wall along the left bank of Rush Creek to protect the area in the vicinity of High Street.

In addition, structures for drainage, traffic crossing over and through the levees, bridge alteration or removal, and utility and sewer system changes have been built, as well as five pumping stations.

The improvements were designed to provide protection against river flows nearly 80 percent greater than the peak flood on Rush Creek, recorded in 1950. It is estimated that $3,099,000 in damages have been prevented by the project through September 1990.

Total Federal cost of the project was $2,610,979. Cost to local interests was $326,000 for lands and alterations of bridges and utilities. The work was substantially completed in the fall of 1968. A bridge relocation and track raise to complete the project was accomplished in 1969.

In response to a request from local authorities, the Rushford project was inspected on May 18, 1972. Bank erosion was found prevalent, and remedial work was undertaken to halt the erosion. Repair consisted of shaping and riprapping banks and was accomplished at a cost of $160,354. The work was completed in 1974.

A construction contract for additional remedial work was awarded in September 1977 to correct a severe erosion problem and to prevent further damage to the project upstream of the Minnesota Highway No. 43 bridge. Also included in the contract was construction of a ditch outlet structure near Rush Creek and a roadway safety improvement. Construction was completed in 1979 at a cost of $421,000.

Zumbro River, (Lower Reach)
Completed Project, Flood Control —
Local Protection
(St. Paul District)

The 1965 Flood Control Act authorized improvement of the Zumbro River near its mouth below Kellogg, Minnesota, to alleviate damages to adjacent rural areas from flooding. The project plan provided for approximately 15,900 feet of continuous channel improvement, including two channel cutoffs, a system of continuous setback levees totaling about 23,500 feet paralleling both banks of the river along the channel enlargement reach, and slope protection of river-bank areas susceptible to bank erosion.

It is estimated that $1,697,000 in damages have been prevented by the project through September 1990. The total Federal cost of the project was $1,284,100. Costs to local interests were about $110,000. Construction was initiated in 1972 and the project was completed in June 1974.

Root River at Rushford

Houston,
Project Underway, Flood Control —
Local Protection
(St. Paul District)

The Root River Valley has a long history of floods occurring nearly every year at some point in the basin. Flooding depths are generally quite substantial because of the narrow shape of the river valley. At Houston, Minnesota, the 100-year flood would cause about $15 million in damages (October 1988 price levels) and reach an average depth of 4 feet over almost the entire city.

A project for flood damage reduction was authorized for construction by the 1986 Water Resources Development Act. Principle project features include 2.4 miles of levee, 0.5 mile of road raise, an interior drainage pumping station, road and rail closures, a recreation trail, and related recreation features. The estimated Federal cost of the project, including an estimated inflation allowance through the construction period (October 1990 price levels) is $4,860,000 and the estimated non-Federal cost is $2,080,000 of which $386,000 is a cash contribution.

Detailed design of the recommended plan is underway which would provide flood damage reduction measures for the city of Houston.

Rochester
Project Underway, Flood Control —
Local Protection
(St. Paul District)

Rochester is located in Olmsted County, in southeastern Minnesota on the South Fork of the Zumbro River, a tributary of the Mississippi River. The Water Resources Development Act of March 7, 1974 authorized the undertaking of the first stage of advance engineering and design for a channel modification and levee project at Rochester. The Phase I report was transmitted to Congress on April 27, 1979 authorizing Phase 2 advance engineering and design. The project was authorized for construction by the 1986 Water Resources Development Act.

The proposed plan consists of approximately 8 miles of channel modifications, 2.4 miles of levees, 4 drop structures, and recreation features including hiking and biking trails. The project, combined with a system of upstream reservoirs under construction by the Soil Conservation Service will protect Rochester against approximately the 0.5 percent chance (200 year) flood.

Estimated Federal cost of the project including an estimated inflation allowance through the construction period (October 1990 price levels) is $88,400,000 and the estimated non-Federal

cost is $31,700,000 of which $9,269,000 is a cash contribution.

The Local Cooperation Agreement was signed in August 1987. Construction began in September 1987 on the first of ten project construction stages. Additional construction contracts were awarded in June 1988, September 1988, May 1989, and February 1990. Advanced engineering and design is continuing on the remaining stages. Construction completion is scheduled for 1995.

Heavy rains at Rochester in July 1978 caused severe flooding and resulted in several deaths and extensive property damage.

Plum Creek, New Haven Township,
Completed Project, Section 208 —
Flood Control
(St. Paul District)

In April 1981 a tornado placed a considerable amount of tree and brush debris in a reach of Plum Creek. Damage began at the confluence of Plum Creek and the South Branch of the Zumbro River and extended 2 miles upstream. The debris plugged the channel and represented a flood threat. At the request of New Haven Township, the problem was investigated under the authority of Section 208 of the Flood Control Act of 1954, as amended. The natural channel capacity of the creek was restored by clearing and snagging in the winter and spring of 1983. The Federal project cost was $31,100. The non-Federal project costs were an estimated $1,500.

Cannon River at Faribault
Completed Project, Section 14 -
Emergency Bank Protection
(St. Paul District)

The project, authorized by Section 14 of the 1946 Flood Control Act, provides for riprap bank protection along approximately 440 feet of shoreline. The bank protection was constructed to eliminate continued erosion which threatened a township road and a county access road that serves a county wilderness park. The project consisted of the placement of pervious fill and riprap along with suitable bedding material along the problem area. Construction was completed in the

Heavy rains at Rochester in July 1978 caused severe flooding and resulted in several deaths and extensive property damage.

summer of 1989 at a Federal cost of about $72,250.

Jarrett and Millville, Zumbro River
Completed Project, Section 14 -
Emergency Bank Protection
(St. Paul District)

The project sites are located on the left bank of the Zumbro River. The first site is about 1/2 mile downstream from Jarrett, Minnesota, and the second is about 1 1/4 miles downstream of Millville, Minnesota. The sites are about 16 miles northeast of Rochester, Minnesota in south-central Wabasha County, in southeastern Minnesota.

The project to protect the streambank from erosion that is threatening County State Aid Highway 11 was authorized under Section 14 of the 1946 Flood Control Act, as amended. The initial appraisal reports were dated June 1986 and March 1987 for Millville and for Jarrett, respectively. The recommended plan consists of placing 2,200 tons of rockfill along 700 feet of the riverbank to protect the road from further erosion at the Millville site, and minor excavation and placing 11,450 tons of rockfill along 1,130 feet of the riverbank to protect the road from further erosion at the Jarrett site. The project was approved for construction of the Chief of Engineers on July 22, 1988.

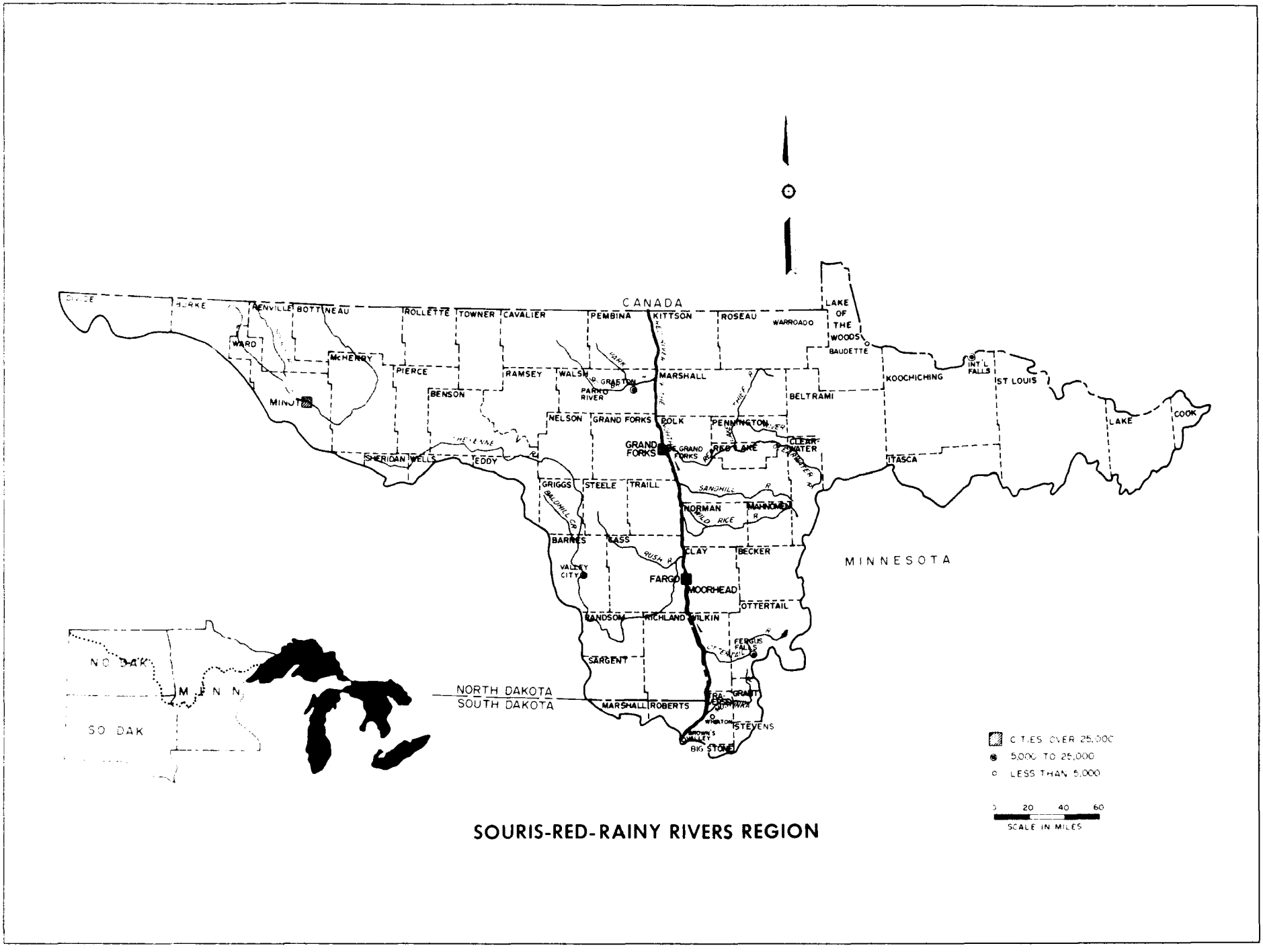
A construction contract for slope protection was awarded on September 19, 1988. Construction was completed in April 1989 at a total Federal cost of $175,500. The total non-Federal cost was $81,000. The project was turned over to Wabasha County in September 1989.

Root River at Hokah
Completed Project, Section 14 -
Emergency Bank Protection
(St. Paul District)

The project. authorized by Section 14 of the 1946 Flood Control Act, provided for rockfill bank protection along approximately 1,500 feet of shoreline. The bank protection was constructed to eliminate continued erosion which progressed to the outfall pipe and threatened the city wastewater treatment plant on the Root River. The project consisted of clearing and snagging, excavation, placement of rockfill along the toe halfway up the bank, and extension of the outfall pipe along the problem area. Construction was completed in the fall of 1990 at an estimated cost of $296,000 of which $222,000 is Federal and $74,000 non-Federal.

Chapter VI

Souris-Red-Rainy Rivers Region



SOURIS-RED-RAINY RIVERS REGION

Souris-Red-Rainy Rivers Region

The Souris-Red-Rainy Region is located along the northern boundaries of North Dakota and Minnesota and extends a short distance into South Dakota. It includes the Souris River, Red River of the North, and Rainy River basins, which drain some 60,000 square miles in the United States. The topography of the region includes open, rolling prairie, upland hills, flat valley plains, swamplands, rugged hills and rock outcrops interspersed with lakes and streams. Annual precipitation varies from less than 14 inches in the west to 28 inches in the east. This is adequate for crop production during normal years; however, in the western portion of the region, occasional periods of severe drought have occurred. Natural resources include fertile soil, petroleum, natural gas, lignite, sand and gravel, peat, iron and copper, wetlands and wilderness.

Economic Development

Agriculture and agriculture-oriented industries are the principal sources of income; however, the Rainy River basin also depends upon timber and tourism for a portion of its economic well-being. The region's 1989 estimated population, about 952,000, is largely rural, with few urban areas of more than 2,500. The largest urban center is Fargo, North Dakota-Moorhead, Minnesota, which had an estimated 1989 population of 100,000. About 16,000 Indians reside on six reservations in the region.

Water Resource Needs

Water resource needs of the basin include flood damage reduction, low flow augmentation for water quality control, water supply and fishery enhancement, and recreation improvements. Flood damage control is the most critical. Flooding along the main stem of the Red River and its tributaries and the main stem of the Souris River has been severe. Despite an abundance of lakes and streams in the eastern portions of the basin, there are almost no bodies of water in the central and western portions. Low flow augmentation is desired along the main stem of the Souris River. Water-based recreation provides another problem area. The water imbalance has created a high demand for water- based recreation throughout the basin.

Red River of the North Basin, Minnesota and North Dakota,
Comprehensive Study Underway — Flood Control
(St. Paul District)

The purpose of this study, authorized by Congressional Resolutions in 1949, 1950, 1954, 1961, 1963, 1966 and 1974, is to develop a coordinated water use program for the basin. Public meetings were held throughout the basin in 1950 and 1951 and additional meetings have been held for each of the interim studies. Each interim study is being coordinated with interested Federal, State, and local agencies.

Approximately 2.5 million acres are subject to streambank flooding. Often, plugged culverts and ditches have extended this flooding considerably beyond the limit of direct overflow. Agricultural land constitutes the major portion of the flood area, but several large cities and many small communities also are subject to flooding. A number of potential solutions are under study for flood control, as well as water supply and water quality, conservation of fish and wildlife, and recreation.

Status: Interim feasibility reports completed to date under the Red River of the North authorization have led to several projects now completed or underway. In Minnesota, construction of the Wild Rice River - South Branch and Felton Ditch project was completed in 1984 and the Twin Valley Lake, Wild Rice River project is currently in an inactive status. Details of these projects are contained elsewhere in this book. In North Dakota, the Sheyenne River flood control project is under construction and the Grafton project is in an inactive status. Studies conducted on the Red Lake River in Minnesota and the Goose River in North Dakota were discontinued due to apparent lack of economic feasibility. Urban water resources studies were completed for the Grand Forks-East Grand Forks and the Fargo-Moorhead metropolitan areas which will provide guidance for the cities to accommodate their future growth. Details of these interim studies are contained elsewhere in this book. Water resources problems were also investigated in the Devils Lake subbasin and in the rural areas of Pembina and Walsh counties in North Dakota (farmstead flood protection).

A Technical Resource Service for the Red River of the North Basin was authorized by the Water Resources Development of Act of 1988. The purpose of the Service is to provide a full range of technical services for the development and implementation of State and local water resource initiatives. This ongoing program was initiated in 1991.

A multi-year drought increased interest in review of the low flow operation of the existing reservoirs and general low flow and water supply planning in the basin. The Water Resources Development Act of 1990 authorized planning in the Red River Basin for water supply, drought emergency management, and related low flow problems.

Fargo-Moorhead Urban Water Resources Study,
Completed Multi-purpose Study
(St. Paul District)

Fargo and Moorhead lie along the Red River of the North, almost due south of the Grand Forks-East Grand Forks urban area. A study of the flood control and water resources problems in a 13-township area that includes Fargo and Moorhead was conducted under the Red River of the North Basin authorization. Initiated in 1979 and completed in 1985, the urban study specifically covered flood control, water supply/conservation, and energy conservation.

The flood control studies recommended that two communities ask the Corps to conduct detailed studies of flood damage reduction measures and that all study area communities adopt/enforce sound flood plain management practices to minimize future flood damages. They also recommended that the hydro-

logic, hydraulic, and topographic information developed during the study be used by the Federal Emergency Management Agency to update existing flood insurance studies for Fargo and Moorhead and by local communities to prepare emergency flood fight plans, design bridges, and determine instream storage for water supply/conservation. The water supply/conservation studies revealed that local potable water sources could continue to meet the needs of the urban areas through the year 2030. These studies also indicated that rural communities would continue to meet their own needs. Various water conservation measures were found to be cost-effective and were recommended. Energy conservation studies included a thermography survey to identify heat losses in study area residences and a newspaper recycling promotion to increase the public's awareness of the benefits of recycling.

Grand Forks-East Grand Forks Urban Water Resources Study,
Completed Multi-purpose Study
(St. Paul District)

Grand Forks and East Grand Forks lie along the Red River of the North, which forms the border between North Dakota and Minnesota. The study covering this urban area was initiated in 1975 under the Red River of the North Basin authorization and has since been completed. It addressed the following water-related needs and problems in the area: flood control, water supply augmentation and treatment, water quality and pollution control improvement, and wastewater management.

Flood control studies for East Grand Forks showed that the flood barrier plan authorized in the mid-1950's was still feasible, as were variations of the plan at the original interest rate. Studies for Grand Forks covered a wide range of structural and nonstructural plans, two of which were analyzed further. A reconnaissance study is scheduled for fiscal year 1990 to further address the flood damage reduction potential at Grand Forks. As a result of the flood control studies, flood emergency plans for the two cities were prepared. Urban drainage studies recommended that Grand Forks adopt ordinances to prevent future runoff from exceeding current levels. This would allow the city to design storm sewer systems to handle existing peak rates. The water supply studies revealed that both cities had adequate water sources through the year 2030. It was recommended that rural water supply associations and self-supplied water users continue to satisfy their own needs. Water conservation practices were discussed as viable means of reducing capital and operating costs of treatment and supply facilities. A drought emergency plan was also developed. Wastewater studies recommended separate treatment facilities for the various communities for cost effectiveness. These studies also recommended separating Grand Forks' combined sewers, which are the most serious untreated stormwater pollution source in the area.

Lake of the Woods, Authorized
Multipurpose Study Not Underway
(St. Paul District)

Lake of the Woods is located in northwest Minnesota, on the border with the Province of Manitoba. The level of the Lake of the Woods is regulated to the extent provided in international agreements, with the object of securing for the inhabitants of Canada and the United States the most advantageous use of the waters in the lake and the waters flowing into and from the lake on each side of the boundary between the two countries. Outputs from the project include flood control, navigation, domestic and sanitary water supply, commercial fishing and recreation. Since the land was originally acquired and the protective works and measures were constructed, no studies have been made in recognition of changed conditions. The protective measures are failing, and the Corps was determined to be responsible for maintenance and repair of specific features. In addition, there have been, and currently are, claims that land is being flooded by lake regulation in areas where the United States does not have flowage easements. A study is required to determine the existing land requirements for lake regulation and the protective measures necessary to ensure compliance with international agreements. A study of the Lake of the Woods problem area was authorized by Section 116 of the Water Resources Development Act of 1990. To date, no funds have been provided to initiate the study.

Water Supply,
Minnesota and North Dakota,
Authorized Study Not Underway
(St. Paul District)

The study area includes the Red River of the North Basin, located in eastern North Dakota and northwestern Minnesota. A continuing multi-year drought renewed interest in low flow planning and water supplies for the Red River of the North Basin. Local and state officials have expressed significant concern about water supply for municipal, rural, industrial, agricultural, and fish and wildlife purposes. Closely related issues are water quality, wastewater management, and in-stream uses of low flows. A study, authorized by Section 116 of the Water Resources Development Act of 1990, would include an accounting of water demands and existing availability under normal, restricted and emergency conditions. It would also identify alternatives to conserve and augment river flows during shortages. Another critical area is to identify the pertinent institutional structure and the alternative contingency actions that might be taken by each institution during low flows. The study must also recognize Treaty requirements for the quality and quantity of flows of the Red River entering Canada. Treaty Trust implications must be considered at the Leech Lake and

Orwell Lake and Dam

Fort Totten Indian Reservations. Treaty Trust considerations will include water demands at the reservations and the cooperative planning of any proposed low flow management plan for the Red River Basin. The study would be coordinated with the Bureau of Reclamation concerning authorized water supply deliveries from the Garrison Diversion Project to Fargo, Moorhead, and nearby communities. Study outputs would include basin-wide alternatives to conserve and augment low flows and water supplies, drought management decision/coordination process for pertinent agencies and possible concepts for improved use of available storage contained at 5 existing Corps of Engineers reservoirs. To date, no funds have been provided to initiate the study.

Lake Traverse and Bois de Sioux River, Minnesota, North Dakota and South Dakota,
Completed Project, Flood Control — Reservoir
(St. Paul District)

The Lake Traverse and Bois de Sioux River project, authorized by the Flood Control Act of 1936, was completed in 1948. The cost to date including recreation facilities is $1,339,727. It provided for use of Lake Traverse as a flood control and water conservation reservoir and for channel improvement in the river below the lake.

The main structure consists of a 14,500-foot earth dam and a concrete control structure at the north end of Lake Traverse near White Rock, South Dakota. A secondary control structure at Reservation Highway near Wheaton permits control of the upper section of the reservoir at a slightly higher elevation. A 5,000- foot embankment at the south end of Lake Traverse to protect Brown Valley, and channel improvement for 24 miles below the main dam, completed the project.

The area is popular for waterfowl hunting and is used extensively for fishing, boating, swimming, and other activities. Access points, parking areas, boat landings, launching ramps and a swimming beach have been made available.

Operation of the project has reduced flood stages at downstream points so that damages prevented are estimated to total $13,759,000 through September 1990. Cost of maintenance through September 1990 was $4,676,698. The annual cost of maintenance during the past 5 years averaged $371,605.

Orwell Lake, Otter Tail River
Completed Project, Flood Control — Reservoir
(St. Paul District)

The Orwell Dam and Lake is located on the Otter Tail River near Fergus Falls. It provides protection from floods during high water flows and, in conjunction with other reser-

voirs in the basin, provides increased flow during low water periods for water supply and pollution abatement at points on the Red River. It is estimated that the reservoir, together with the Otter Tail River improvement, has prevented $9,015,000 in damages through September 1990. The structure consists of an earth dam and concrete control works with a tainter gate.

The project, authorized by the Flood Control Acts of 1948 and 1950, was completed in 1953. The Federal cost of this project through September 1990 totaled $6,923,023. Of that sum, $1,916,753 was for new work and $5,006,270 was for maintenance. The average annual cost of maintenance during the past 5 years has been about $413,276.

Most of the land, except for a part at the dam-site, has been made available to the Minnesota Department of Natural Resources for wildlife conservation purposes. The area is managed for waterfowl and upland game and is open to public use for boating, fishing and other outdoor recreation. Additional recreational facilities are being planned by the Corps of Engineers in cooperation with the State of Minnesota.

Emerson Manitoba - Noyes, Minnesota, Red River of the North
Completed Project, Section 205 —
Flood Control
(St. Paul District)

The unincorporated village of Noyes is located in Kittson County in extreme northwestern Minnesota about 80 miles north of Grand Forks, North Dakota. Noyes is situated on the right overbank of the Red River of the North, approximately one-half mile from the channel.

The project consists of a "ring" levee which protects both Noyes and the city of Emerson, Manitoba, Canada. The project has three basic components: an upgrade of the existing Emerson, Manitoba, emergency levee to provide 100-year flood protection; construction of a 3,800-foot-long levee at Noyes, Minnesota to provide 100-year flood protection; and construction of a 2,000 foot-long International levee in Minnesota parallel to the International boundary. The levees provide a continuous levee system around the two communities. The levees have a 10-foot top width, side slopes of 1 vertical on 3 horizontal, and vary in height from 7 to 12 feet. The interior flood control facilities consist of one ponding area and two gravity outlets. The project was approved by the Chief of Engineers for construction on July 26, 1988, under the authority contained in Section 205 of the 1948 Flood Control Act, as amended.

A contract for construction of the flood control project at Noyes was awarded in September 1988 and completed in the fall of 1990. The project is scheduled to be turned over to local interests in 1991 after completion of the operation and maintenance manual and an audit.

Fargo - Moorhead
Completed Project, Section 208 —
Flood Control
(St. Paul District)

The project, authorized by Section 208 of the 1954 Flood Control Act, as amended, provides for snagging and clearing a 9.7-mile reach of the Red River of the North through a portion of the metropolitan Fargo, North Dakota - Moorhead, Minnesota area. The improvement will primarily consist of removing fallen, dead, and leaning trees up to 20 feet back from the edge of the riverbank and cutting trees in the water off at the ice line. Work will be done when the riverbank is frozen to minimize damage to the environment and buried cultural artifacts. Debris would be burned or disposed of in approved sites. A number of standing dead trees would be left on the riverbank for cavity-nesting birds.

The contract for clearing was awarded in February 1990 and the snagging contract was awarded in January 1991. The project was completed in the spring of 1991 at a Federal cost of $231,500.

Gentilly, Red Lake River
Completed Project - Flood Control
(St. Paul District)

The project, authorized by Section 603 of the Water Resources Development Act of 1986 (Public Law 99-662) is located on the left bank of the Red Lake River approximately 1 1/2 miles west of Gentilly where erosion was endangering nearby Polk County-State Aid Highway No. 11. The project involved excavation and the placement of earth fill, bedding material, and riprap along the approximate 1200-foot reach of riverbank affected by erosion. Construction of the project began in October 1989 and was completed in May 1990. The total Federal cost of the project was $330,000.

Halstad, Red River of the North
Completed Project, Section 205 —
Flood Control
(St. Paul District)

Halstad, located on the Red River of the North, has experienced periodic flooding. In 1969, a temporary levee was constructed along the west side and portions of the north and south sides of the city. However, the temporary nature of the levee and its lack of continuity provided an insufficient degree of flood protection. In June 1975, the City Council requested the Corps to study the feasibility of providing improved flood control measures. A reconnaissance report completed in August

1976, indicated additional flood control measures were potentially feasible and recommended more detailed study. Detailed studies under the authority of Section 205 of the 1948 Flood Control Act, as amended, were completed in 1982. Construction of a flood control project was initiated in the fall of 1983 and was completed in 1986 at a Federal cost of $2,012,000. The project, which consisted of raising and extending the levee, constructing closures at road and railroad crossings, and providing interior drainage facilities, will provide protection from a flood with a 0.4- percent chance of occurring in any one year.

Lost River,
Completed Project, Flood Control —
Local Protection
(St. Paul District)

The 1958 Flood Control Act authorized improvement of Lost River, a tributary of the Clearwater River in Polk and Red Lake Counties. The project provides for clearing the channel of fallen trees, brush, stumps and debris for almost 20 miles from the mouth upstream to a point two miles west of Oklee.

The channel has been deepened, widened or straightened from that point for 23 miles farther upstream to about three miles north of Gonvick. Ten bends in the river were cut in this reach, thus shortening the river by about three miles. Seven drop structures, 14 outlet structures (which reduce erosion where drainage ditches empty into the river) and seven transition sections (which provide a gradual slope in the ditch as it joins the channel) were built.

Stone riprap now protects the channel at three bridges and at one 315-foot section of bank. Two gated culvert ditch outlets were built and 12 bridges removed or altered. An estimated $3,904,000 in damages has been prevented through September 1990 by these improvements.

The improvements were completed at a cost of $563,000 in Federal funds and a cash contribution of $246,900 from local interests. Maintenance is by local interests.

Mustinka River,
Completed Project, Flood Control —
Local Protection
(St. Paul District)

The Flood Control Acts of 1948 and 1950 authorized improvements on the Mustinka River near Wheaton. The project consisted of 36.1 miles of straightening, clearing and enlarging of the Mustinka River and its tributaries. It is estimated that because of the improvements, $3,302,000 in damages have been prevented through September 1990. Construction was completed in 1958 at a total Federal cost of $440,800. Maintenance is by local interests.

Oslo, Red River of the North,
Completed Project, Section 205 —
Flood Control
(St. Paul District)

The village of Oslo is located on the Red River of the North about 20 miles north of Grand Forks, North Dakota. The village had experienced flood damages periodically as in 1965 when the entire community was inundated. An emergency levee, constructed in 1966 and raised in 1969, protected the village against floods during the spring of those years. The Chief of Engineers approved a project for flood control, consisting of a levee encircling the village generally along the existing emergency levee alignment, together with interior drainage facilities and other appurtenant works.

The project, authorized under Section 205 of the 1948 Flood Control Act, as amended, was completed in 1976. The city subsequently requested that the project be modified for permanent flood protection along a reach of the Red River of the North in lieu of the plan providing for a sandbag closure. A report was forwarded to the Chief of Engineers on February 27, 1976 for approval. Subsequent investigations indicated that extremely unstable bank conditions precluded construction of any permanent works. The unstable bank conditions further threatened the integrity of existing permanent project features, including that reach of bank upon which the sandbag closure is required. Bank stabilization measures to remedy this situation were completed in 1983.

The total Federal cost of the project was $1,960,200 including cost for bank stabilization. It is estimated that because of the improvements, $8,193,000 in damages have been prevented through September 1990.

Otter Tail River,
Completed Project, Flood Control —
Local Protection
(St. Paul District)

The Flood Control Acts of 1948 and 1950 authorized improvements on the Otter Tail River near Breckenridge. The project consisted of about 11.4 miles of straightening, clearing and enlarging of the Otter Tail River above Lake Breckenridge. It is estimated that the improvement, together with the Orwell Dam and Lake, has prevented $9,015,000 in damages through September 1990. Total Federal cost of the project, completed in 1954, was $174,800. The improvement is maintained by local interests.

Red Lake and Clearwater Rivers,
Completed Project, Flood Control — Local Protection
(St. Paul District)

The 1944 Flood Control Act authorized improvements on the Red Lake River-Clearwater River near Thief River Falls. The project was completed in 1956. Project features included about 27 1/2 miles of clearing, straightening, and enlarging of the Red Lake River channel between High Landing and a point 4 1/2 miles east of the west boundary of the Red Lake Indian Reservation. At that point a small concrete dam was built to restore the marshes for wildlife in the reservation between that dam and a point some three miles below the outlet of Red Lake. The channel was improved for about three miles below the dam.

Also included were alterations of the existing control structure built by the Indian Service at the outlet of Lower Red Lake, about seven miles of highway raising in the vicinity of Lower Red Lake, and 47.3 miles of channel improvement in the Clearwater River channel from a point near Plummer to above Ruffy Brook.

The Indian Service reconstructed a bridge on the reservation, with reimbursement of costs by the Corps of Engineers. In 1966 and 1967, additional dikes with inlets and outlets for the marshes were constructed to restore the marshes to their former conditions.

It is estimated that the improvement has prevented $10,765,000 in damages through September 1990.

Total Federal cost of new work, including work on the marshes, was $4,120,000. Total non-Federal costs, including a cash contribution of $30,000, were $55,000. Federal cost of operation and care of the outlet structure through September 1990 is $1,282,358. The annual cost of maintenance during the past 5 years averaged $98,883. Local interests maintain the channels.

Sand Hill River,
Completed Project, Flood Control — Local Protection
(St. Paul District)

The Flood Control Acts of 1948 and 1950 authorized improvements on the Sand Hill River near Beltrami. The project consisted of about 20 miles of straightening, clearing and enlarging of the Sand Hill River. Construction was completed in 1957. Damages prevented through September 1990 by the project are estimated at $9,700,000. The Federal cost of the project was $548,800. Damaged by floods and ice in 1965, it was repaired with emergency funds at a cost of about $134,300. Channels are maintained by local interests.

Wild Rice-Marsh Rivers,
Completed Project, Flood Control — Local Protection
(St. Paul District)

The Flood Control Acts of 1948 and 1950 authorized improvements on the Wild Rice-Marsh Rivers near Ada. The project consisted of 35.8 miles of straightening, clearing and enlarging of Wild Rice and Marsh River channels. Damages prevented through September 1990 by the project are approximately $11,410,000.

Construction of the Wild Rice River portion was completed in 1952, the Marsh River portion in 1954. Total Federal cost of the project was $405,100. The project is maintained by local interests. Due to changed conditions which cause excessive maintenance and reduce project effectiveness, the existing project and the downstream (lower 18 miles) channel of the Wild Rice River were reevaluated (see Wild Rice-Marsh Rivers, Completed Study, Flood Control — Local Protection).

Wild Rice River — South Branch and Felton Ditch, Completed Project, Flood Control — Local Protection
(St. Paul District)

The 1968 Flood Control Act authorized construction of improvements on the South Branch of the Wild Rice River and Felton Ditch in Clay and Norman Counties. These streams are tributaries of the Wild Rice River, which is a tributary of the Red River of the North in northwestern Minnesota.

Improvements included increasing the capacities of the two streams by widening and clearing existing channels through the flood plain. Short reaches of low flanking dikes were constructed on both banks of Felton Ditch near the upper limit, and drop structures were placed in both channels. Several highway bridges and a railroad bridge were altered.

Construction was completed in 1984 at a total Federal cost of $4,534,700. A contract for remedial work to realign or relocate the outlets of 103 culvert inlets was awarded in September 1987 and completed in 1989. Total cost for the remedial work was $1,086,000.

Middle River at Argyle,
Project Underway, Section 205 — Flood Control
(St. Paul District)

Flood problems at Argyle are similar to those at other Red River Valley communities. The flat terrain causes widespread

flooding when the rivers exceed the floodstage. The largest discharges usually occur in the spring in conjunction with rapid snowmelt. However, the largest flood of record occurred in July 1975 when peak flows at Argyle reached 4,260 c.f.s. Floods of higher magnitude are likely to occur as the 1975 flood has an estimated recurrence interval of only 26 years.

In early 1985, a detailed project report was completed under the authority of Section 205 of the 1948 Flood Control Act, as amended. The report recommended a plan that called for a flood barrier to protect the main developed part of Argyle against the 1-percent chance flood. The plan includes a levee along the northeast, east, and southeast parts of town with intermittent road raises along the south and west corporate limits. County Highway 4 would serve as the flood barrier along the north side from County Highway 108 (west corporate limit) to Elm Avenue where the levee begins. Interior flood control facilities include a system of interceptor ditches and pipes which convey stormwater to 3 ponding areas, each having a gated outlet. The plan also included the relocation of 12 flood prone residences located on the north side of the city outside of the area protected by the flood barriers. A stage 1 construction contract for the flood barrier system was awarded in September 1985 and completed in May 1987. Stage 2, the final stage construction contract, was awarded in September 1989 and is scheduled for completion in the fall of 1991. Relocation of the 12 residences was completed by the city in 1986. Total estimated Federal cost of the project is $2,375,000.

Roseau River, Project Underway,
Flood Control — Local Protection
(St. Paul District)

The 1965 Flood Control Act authorized construction of improvements on the Roseau River. The project provided for works along the Roseau River between the city of Roseau and the Canadian border, which included 44.4 miles of channel modification, 7.8 miles of earth levees, and related works. The project would have provided 30-year degree of protection upstream of the dam in the city of Roseau, 50-year protection for the area downstream of the dam and extending to Roseau Lake, and 10-year protection for the area downstream of Roseau Lake.

The originally authorized project provided for construction of three reaches of levee on the left bank of Roseau River where the natural banks are low. One of these, 0.85 mile in length, was to be built opposite the mouth of Sprague Creek while another would extend from Duxby to a point 8.4 miles downstream. The third would take an existing levee in Canada and extend it a short distance into the United States. In addition,

Baudette Harbor, Lake of the Woods

Warroad River and Harbor, Lake of the Woods

funds were to be furnished to Canada for construction of channel improvements to offset adverse effects from increased flows at the border resulting from channel improvements in the United States.

Construction of the originally authorized project was never initiated. Only one component of the originally authorized project remains economically feasible. This component is referred to as the Duxby levee. The Water Resources Development Act of 1988 modified the previous authorization to provide for the construction of this 6-mile flood control levee, which begins at a point approximately two miles upstream of Duxby. The estimated Federal cost of the project (October 1990 prices) is $356,000 and the estimated non-Federal cost is $119,000. A construction contract was awarded in June 1991; project completion is scheduled for late 1991.

East Grand Forks,
Authorized Project Not Underway,
Flood Control — Local Protection
(St. Paul District)

The Flood Control Acts of 1948 and 1950 authorized a local flood protection project for East Grand Forks, Minnesota. Subsequently, detailed plans for this project were prepared, but construction was not initiated because of noncompliance with a formal request on October 26, 1956 for assurances of local cooperation. Authorized expired in 1961 at the end of the 5-year period within which local interests were required to furnish these assurances.

However, following the floods of 1965 and 1966, local interests were in favor of reauthorization of the project, and furnished a resolution indicating willingness to meet the requirements of local cooperation. The original plan of improvement, providing for levees, floodwalls and interior drainage work in conjunction with nonstructural measures, has been reevaluated and modified to include measures that would protect against a flood having an occurrence interval of about once in 156 years. Structural components include 17,885 feet of earthen levee, 1,958 feet of concrete floodwall, one pumping station and other interior drainage facilities, acquisition of all lands, easements, and rights-of-way to include 98 structures along the right-of-way, and modifications to utilities. Nonstructural components include the evacuation of 90 structures from the floodplain, floodproofing, floodplain zoning, flood warning and forecasting, flood insurance and emergency plan of action. The plan also provides for emergency closure of seven road or railroad openings and 18,980 feet of emergency freeboard barrier. Legislation was introduced in Congress, and the Flood Control Act of 1970 provided for extension of the expiration date for furnishing assurances of local cooperation to April 17, 1975. A local assurance agreement was provided by the city of East Grand Forks on March 27, 1975.

The estimated Federal cost of the project, based on October 1986 price levels, is $22,000,000. Non-Federal costs amount to

about $9,600,000 of which $1,300,000 is a cash contribution. The city of East Grand Forks withdrew its support of the project in a letter dated July 9, 1986. The General Design Memorandum was completed in February 1987. Future design stages and construction are not scheduled. The project was reclassified from active to inactive status in August 1988.

Twin Valley Lake, Wild Rice River,
Authorized Project Not Underway,
Flood Control — Reservoir
(St. Paul District)

The Wild Rice River, a tributary to the Red River, passes through Clearwater, Mahnomen and Norman counties in west-central Minnesota. Recurrent flooding causes serious damage to agricultural, commercial, and public owned properties along the Wild Rice and Marsh Rivers. A project for flood damage reduction was authorized by the Flood Control Act of 1970.

The proposed plan provides for construction of an earth-filled dam on the Wild Rice River near Twin Valley, Minnesota. The primary purpose of the structure is to reduce flood damage downstream and provide a lake for recreation. Project lands not exclusively for flood control or recreation will be set aside for fish and wildlife management.

The estimated Federal cost of the project (October 1986 price levels) is $22,200,000 and the estimated non-Federal cost is $7,700,000.

The project requires additional Congressional authorization for a fish and wildlife compensation plan to offset losses of habitat caused by project construction. The project was reclassified from active to inactive status in August 1988 due to lack of economic feasibility.

Wahpeton, North Dakota - Breckenridge, Minnesota
Completed Study, Flood Control —
Local Protection
(St. Paul District)

Wahpeton, North Dakota and Breckenridge, Minnesota are located at the junction of the Bois de Sioux River on the border between North Dakota and Minnesota and the Ottertail River in Minnesota. Also located on that border and formed by the junction of these two rivers is the Red River of the North. The Wahpeton-Breckenridge area receives some flood control benefit from the operation of two federal reservoirs: Lake Traverse on the Bois de Sioux River and Orwell Reservoir on the Otter Tail River. However, the reservoirs have limited storage capacity and a significant amount of drainage area lies between the reservoirs and the cities. Thus, the cities continue to receive damages from floods and must undertake significant flood fights during periods of high water, such as in 1969, 1979 and most recently, 1989. The agricultural areas located downstream of the reservoirs are subject to flooding from runoff from summer rainstorms. A 13.9 mile channelization project located on the Bois de Sioux and Red Rivers was authorized in 1948, but was never constructed because of marginal economic feasibility at that time. In letters dated March 27, 1987 and April 16, 1987, the City of Breckenridge and the Richland County Board, North Dakota, respectively have requested a restudy of the project. A reconnaissance study was initiated in 1989 and completed in February 1990. The study examined current problems and needs to determine whether the authorized channel project or any other flood control project for the study area was feasible under current conditions. Alternatives examined included the authorized channel project, other channel sizes and configurations, nonstructural plans, and levees in the urban areas. No economically feasible project in the Federal interest could be identified and the project was reclassified to an inactive status in September 1990.

Wild Rice - Marsh Rivers,
Completed Study, Flood Control —
Local Protection
(St. Paul District)

The main channel of the Wild Rice River in Norman County, Minnesota was channelized by the Corps of Engineers in 1954 for approximately 15 miles, generally between the junctions with the Marsh River and the South Branch of the Wild Rice River. The project consisted of channel straightening, clearing and enlarging (See Wild Rice — Marsh Rivers, Completed Project, Flood Control — Local Protection). Portions of the existing channel and spoil bank levees have been damaged in successive flooding events requiring expenditures of Federal Emergency Repair Funds in 1965, 1977, 1978 and 1985. The Wild Rice Watershed District requested the aid and assistance of the Corps of Engineers in reevaluating the existing project and the downstream (lower 18 miles) channel of the Wild Rice River.

A January 1988 reconnaissance report found two feasible alternatives that could be implemented. However, the local Watershed District declined to share in the cost of a subsequent feasibility study. In March 1989, the Board of Engineers for Rivers and Harbors recommended no further study of flood damage reduction measures for the Wild Rice and Marsh Rivers.

Crookston, Study Underway,
Flood Damage Prevention
(St. Paul District)

The study area is on the Red Lake River at the city of Crookston in northwestern Minnesota. The study consists of an evaluation of flood damage reduction measures for the floodprone areas of the city, principally channel cutoffs, levees, and non-structural alternatives. The floodprone areas in Crookston contain about 800 residences and are located in six reaches adjacent to the Red Lake River. The flood of 1950 inundated all these areas. However, the subsequent floods of 1965, 1966, 1967, 1969, 1975, 1978, and 1979, even though larger than the 1950 event, did not flood major portions of the city due to locally

constructed temporary levees and extensive flood emergency activities during, and just prior to, the flood event. Although these past flood fighting activities have prevented major catastrophes at Crookston, much of the existing temporary levee system has deteriorated. Most of the levees are considered high risk structures, and as such, provide a false sense of security to many residents of Crookston.

The reconnaissance phase of the study was completed in 1991. The feasibility phase of the study is currently underway.

Red Lake and Clearwater Rivers,
Study Underway,
Flood Damage Prevention
(St. Paul District)

The Red Lake River is a tributary to the Red River of the North in northwestern Minnesota. The Red Lake River at High Landing, Minnesota has a drainage area of 2300 square miles. The river begins at the Red Lake Dam, the outlet of Red Lakes, and enters the Red River of the North at East Grand Forks, Minnesota. The Clearwater River has a drainage area of 1370 square miles at Red Lake Falls, Minnesota. An authorized project was completed in 1956 and included channel modifications on both the Red Lake and Clearwater Rivers and an outlet control structure for the Upper and Lower Red Lakes.

Damages attributed to the operation of Red Lake Dam have been claimed by three basic groups in the Red Lake area since the late 1950's. These three groups are: (1) the Waskish area resort interests on the east end of Upper Red Lake, (2) the Red Lake Reservation Indians on both Upper and Lower Red Lakes, and (3) agricultural interests downstream of Red Lake Dam and the Indian Reservation (High Landing area).

A Problem Appraisal Report for the Red Lake-Clearwater Rivers project was completed in 1985. The report concluded that several of the project features needed further study and recommended that a reconnaissance study be conducted to address added flood control and water needs of the Red Lake-Clearwater Rivers, Minnesota, area. A reconnaissance study was initiated in 1990 and is currently underway.

Baudette Harbor,
Completed Project —
Commercial Navigation
(St. Paul District)

Baudette Harbor, authorized by the River and Harbor Act of March 2, 1919, is located in the city of Baudette at the mouth of the Baudette River, a tributary of the Rainy River. The project as modified in 1945, provides for a channel six feet deep and 75 feet wide extending from the mouth of the river upstream a distance of about 2,000 feet, with an increase in width at the inner end to form a turning basin with a maximum width of 230 feet. The project was completed in 1950 at a cost of $36,415. Maintenance costs to date total $57,768.

Warroad River and Harbor,
Completed Project — Commercial
Navigation
(St. Paul District)

The project authorized by the River and Harbor Act of March 3, 1899 with later modifications, provided for a lake approach channel 300 feet wide, a river channel 200 feet wide, and an enlarged turning basin. The entire channel is about 9,200 feet long. Because the full project width is not necessary for existing commerce, the channel has been dredged to a width of only 100 feet, except for the inner 900 feet which has been widened to 200 feet to form a turning basin. Intermittent maintenance is required.

The cost through September 1990 for this project is $86,105 for new work and $1,221,449 for maintenance. No commercial traffic has been reported in recent years.

Zippel Bay Harbor,
Completed Project — Commercial
Navigation
(St. Paul District)

Zippel Bay Harbor is located on the southern shore of Lake of the Woods near the Canadian border. The plan of improvement, authorized by the River and Harbor Act of 1911, provided for a channel 3,000 feet long, 200 feet wide, and 9-10 feet deep, and for a jetty 2,800 feet long. The dredged channel was completed and the jetty was constructed to a length of 2,200 feet. The remaining portion of the jetty was considered unnecessary to meet navigation requirements.

The original project, completed in 1914, was authorized for commercial navigation to include harbor of refuge benefits. At the time, area commerce depended on lake transportation provided by slow-moving rafts and barges. With the development of road systems in the area, the need for commercial navigation diminished. Use of larger and faster-moving boats and the lack of need for commercial facilities negated the requirement for a harbor. Maintenance of the harbor was discontinued by 1927. The project was recommended for abandonment in House Document No. 467, 69th Congress, 1st Session, but was not acted upon.

The channel has silted in to the extent that the sand beach is continuous about five feet above the water surface (elevation 1060). The opening from the bay to the lake is the meandering natural channel. A few rocks and timbers on shore are all that remains of the jetty.

Pine Creek at Angle Inlet
Completed Project, Section 107 —
Recreational Navigation
(St. Paul District)

The natural channel linking Pine Creek to Lake of the Woods varied considerably in width and depth and severely restricted use of the lake. Improvements authorized by Section 107 of the River and Harbor Act of 1960, provided for a channel extending from the Northwest Angle Inlet of the Lake of the Woods a distance of about 3,000 feet into Pine Creek to a local dock at Angle Inlet, with a maneuvering area at the inner end. The project was completed in August 1963 at a cost of $38,700.

Zippel Bay Harbor, Lake of the Woods
Completed Project, Section 107 —
Recreation Navigation
(St. Paul District)

Zippel Bay forms an ideal natural harbor for small boats from Zippel Bay State Park, a resort and a number of private residences. However, historically the natural channel linking the bay to the lake varied considerably in depth, width and location, severely restricting use of the bay. In 1978 the Minnesota Department of Natural Resources requested an investigation of the feasibility of a reliable access channel. In 1985, the Chief of Engineers approved a small- boat navigation project under the authority of Section 107 of the River and Harbor Act of 1960, as amended. A 1,700 foot long access channel was excavated through the bay mouth bar. The channel is protected by rock jetties on both the east and west sides. A construction contract was awarded in May 1986. The project was completed in late 1987 at a Federal cost of $515,000 and a non- Federal cost of $307,556.

Breckenridge,
Completed Project, Section 14 —
Emergency Bank Protection
(St. Paul District)

The project, authorized by Section 14 of the 1946 Flood Control Act, as amended, provides for riprap protection along the right bank of the Red River of the North from the St. Francis Nursing Home northward a distance of approximately 300 linear feet. The project was constructed to eliminate continued erosion which threatened the city-owned nursing home. It is an extension of an earlier bank protection project constructed by the Corps of Engineers. (See Breckenridge, Red River of the North, Completed Project, Section 14 - Emergency Bank Protection.) Total Federal cost for the project was $75,000.

The city of Breckenridge contributed $22,500 to the project. Construction was completed in January 1990.

Breckenridge, Red River of the North
Completed Project, Section 14 —
Emergency Bank Protection
(St. Paul District)

The project, authorized by Section 14 of the 1946 Flood Control Act, provides rip-rap bank protection along 120 feet of the right bank of the Red River of the North at Breckenridge, Minnesota. The bank protection was constructed to eliminate the threat of erosion damages to a city-owned nursing home and a gas main serving the nursing home and adjacent hospital. The total Federal cost of the project was $27,500. The work was completed in July 1981.

Huot, Red Lake River,
Completed Project, Section 14 —
Emergency Bank Protection
(St. Paul District)

The project, authorized by Section 14 of the 1946 Flood Control Act, provides rip-rap bank protection along 400 feet of the right bank of the Red Lake River at Huot, Minnesota. The bank protection was constructed to eliminate the threat of erosion to adjacent County State Aid Highway 17. The total Federal cost of the project was $64,500. The work was completed in October 1983.

Mahnomen, Wild Rice River
Completed Project, Section 14 —
Emergency Bank Protection
(St. Paul District)

The project, authorized by Section 14 of the 1946 Flood Control Act, provides approximately 400 feet of bank protection along the right bank of the Wild Rice River at Mahnomen. Placement of the bank protection will control bank erosion which threatened city water supply wells and an 8-inch water main located in the vicinity. Construction of the project was completed in 1980.

Red Lake Falls, Red Lake River
Completed Project, Section 14 —
Emergency Bank Protection
(St. Paul District)

The project, authorized by Section 14 of the 1946 Flood Control Act, provides rip-rap bank protection along 630 feet of the right bank of the Red Lake River near Red Lake Falls, Minnesota. The bank protection was constructed to eliminate the threat of erosion to the County State Aid Highway 13 bridge

number 6681. The total Federal cost of the project was $131,000. The work was completed in November 1983.

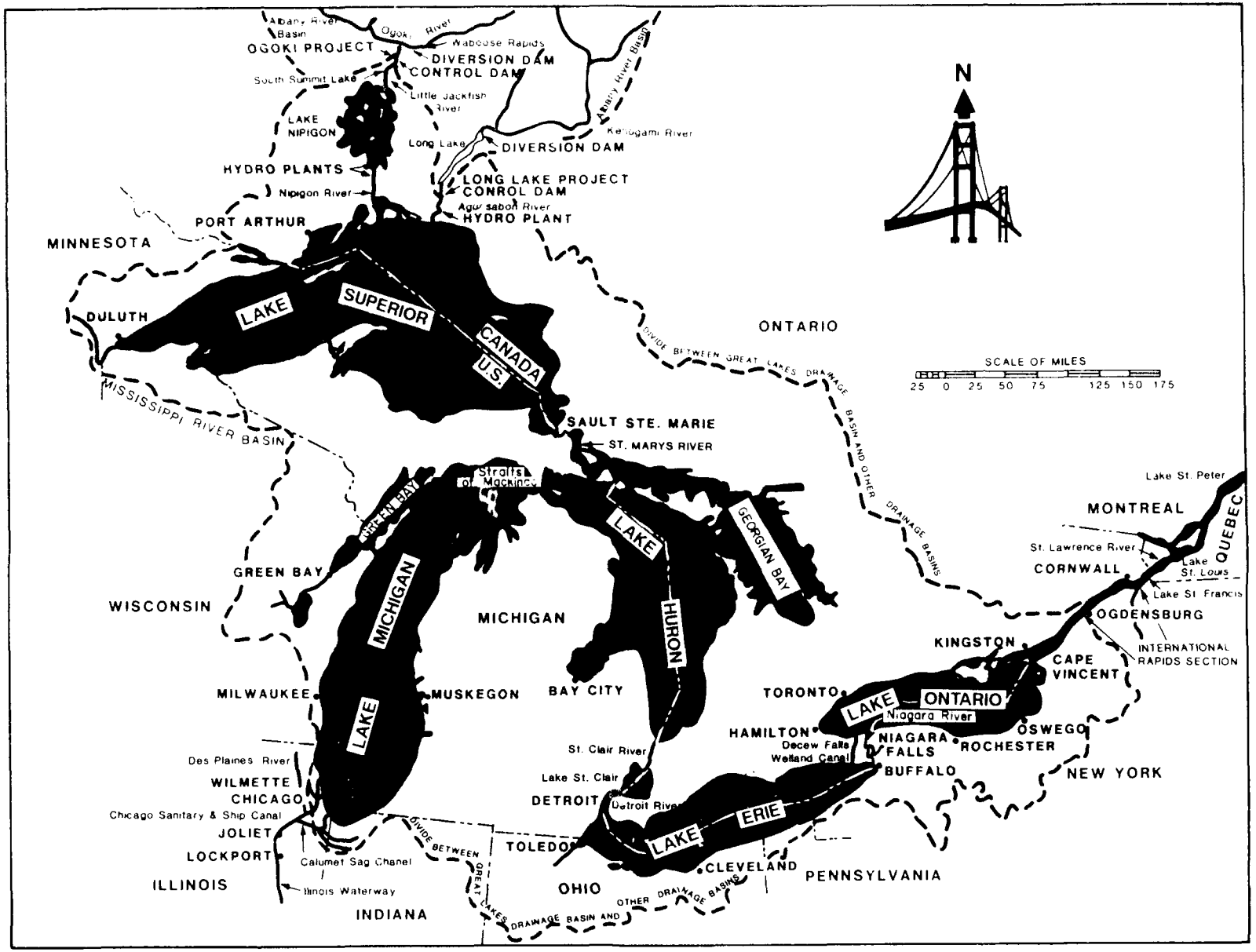
Wild Rice River, Mahnomen
Completed Project, Section 14 —
Emergency Bank Protection
(St. Paul District)

The Wild Rice River was eroding the right bank about 1.4 miles west of the city of Mahnomen, Minnesota. The erosion was threatening Mahnomen County Highway 5 located in west central Minnesota. The project consisted of 1,200 cubic yards of excavation and placement of 850 cubic yards of riprap slope protection along a 440-foot reach.

On June 18, 1985 the Chief of Engineers approved a project for repair under provisions of Section 14 of the 1946 Flood Control Act, as amended. A contract was awarded in August 1985. The project was completed in October 1985 at a total Federal cost of $58,500.

Chapter VII

Great Lakes Region



GREAT LAKES REGION

Great Lakes Region

The Great Lakes Region in the United States and Canada comprises 299,000 square miles, 95,000 of them water and 204,000 land. It covers northeastern Minnesota, essentially all of Michigan, and parts of six other states, with 4,000 miles of mainland shores and 1,500 miles of island shores.

The Great Lakes are connected by the following rivers and waterways: the St. Mary's River, Lake Superior to Lake Huron; the Straits of Mackinac, Lake Michigan to Lake Huron; the St. Clair River, Lake Huron to Lake St. Clair; the Detroit River, Lake St. Clair to Lake Erie; the Niagara River and the Welland Canal, Lake Erie to Lake Ontario; and the St. Lawrence River, Lake Ontario to the Atlantic Ocean. Four of the five Great Lakes are United States-Canadian boundary waters. The international boundary passes through these lakes and their connecting channels. Lake Michigan, however, lies wholly within the United States.

The region was created largely by glaciation, and its formation was, in terms of earth history, only recently completed. The region has been free from the direct influence of glacial ice for approximately 9,500 years. The five Great Lakes, with their outlets and approximate lake-levels as they are today, probably date back less than 3,000 years. The processes of stream and shoreline erosion have made only slight changes in the original topography.

The Great Lakes came into existence during the Pleistocene or Ice Age of earth history. At that time the area contained well-drained valleys and divides of several large rivers. The continental ice cap then developed to a thickness of several thousand feet over much of Canada, and spread southward covering what is now the Great Lakes Region. However, this topography was entirely changed. Parts of the preglacial valleys were deepened by scouring, while other parts were filled by deposits, thus creating the basins of five lakes.

While the ice front was receding northward, gradual thawing left waters ponded between the ice and the exposed glacial deposits. This created a gradually enlarging body of lake waters at levels, in some cases hundreds of feet, above present lake levels and with overflow outlets across present watershed divides. As the ice border receded, the pattern and the levels of the lakes repeatedly were changed as new lower outlets were uncovered. The effect of these glacial lakes on present shorelines is illustrated by such features as the perched wave-cut cliffs of Mackinac Island, the lake-deposited clay flats of Chicago and Toledo, the variable stratified sands and silts constituting or overlying the bluffs along the shores of Lake Erie, Huron, and Michigan, and the sand tracts of the dune areas.

Flow Rates, Climates

Enormous quantities of water are required to effect even small changes in the levels of the lakes. Therefore, comparatively large variations in supplies to the lakes still have little immediate effect on lake levels. Flow rates in the outlet rivers are remarkably steady in comparison with the range of flows observed in other large rivers of the world. Where suitable head exists, these large steady flow make generation of electric power economically feasible.

Average annual temperatures range from 39° on Lake Superior to 48.7° on Lake Erie. Minimum and maximum monthly temperatures occur in February and July, respectively, on all of the lakes. Mean annual precipitation for the entire region is about 32 inches, with a minimum of 26 inches in 1930 and a high of 37 inches in 1951. Annual snowfall ranges from about 40 inches to 120 inches. Estimates of annual evaporation on the surface of the Great Lakes range from a minimum of about 1.5 feet on Lake Superior to a maximum of about 3.0 feet on Lake Erie. The lakes are as a rule ice-free from May to the early part of November. In general, an ice cover does not form on the lakes except in bays and in northern areas between islands.

Resources Development

The region's predominant mineral resources are iron ore, limestone, salt, copper, sand and gravel, and clay. Coal and petroleum are relatively limited in supply. Timber and wood products are important resources that depend upon water for transportation and processing. The glacial overburden has abundant mineral resources to support plant growth, and precipitation has been generally sufficient to develop agricultural potential. Surface and groundwater supplies have been adequate for industry.

In terms of economic development, the dominant characteristics of the Great Lakes are the large bodies of fresh water, the region's location within the highly industrialized North Central United States, and natural resources for manufacturing and agriculture. The water surface makes the Great Lakes the world's largest body of fresh water and provides the means of transporting an average of 170 million tons of freight per year over the Great Lakes-St. Lawrence navigation system.

Although the Great Lakes Region contains only about four percent of the United States land area, it has 13.2 percent of the Nation's population. The 1980 population of the basin was 29.8 million as compared to its 1970 population of 29.3 million. This constituted less than a 2 percent increase in population during that period.

Commercial Navigation

The Great Lakes, connecting channels, and St. Lawrence Seaway form a 2,342 mile waterway from the heart of the North American continent to the Atlantic Ocean.

The first recorded commercial navigation on the Great Lakes (a load of grain) occurred in 1678. For the years (1985-1989), an annual average of 154 million tons has been carried.

Principal items of commerce and their 1989 tonnages are:

Item	1989 Traffic (Million Tons)
Iron Ore	67
Coal	36
Limestone	26
Grain	8
Other	32
Total	169

The opening of the St. Lawrence Seaway in 1958 generated substantial tonnage, especially in grain exports and iron ore imports. Original estimates of traffic predicted 50 million tons by 1968. This was reached in 1970. Traffic is expected to total 250 million tons by 2000.

It is anticipated, given recent developments in the Great Lakes regional economy, that iron ore traffic on the system will stabilize at a lower level than previously projected, but that western coal and grain traffic will show growth over the next decade.

The abundance of iron ore and limestone near the upper Great Lakes, and good quality coal within 200 miles of southerly lake ports is responsible for 50 percent of the nation's steelmaking capacity being located along the south Lake Michigan and western and southern Lake Erie shores. An additional 25 percent of the steelmaking capacity is not in the region (Pittsburgh, Pennsylvania and Youngstown, Ohio) but is served by Lake Erie ports.

Cost of providing the present system, which allows a vessel draft of 25.5 feet, was about $2 billion. It has been estimated that the cargo carried on the Great Lakes generates more than $4 billion annually. This is equivalent to about $18 for every ton carried.

Electric Power

Total 1976 generating capacity in the region's U.S. portion was 45,406 megawatts-5,852 hydro-electric and 40,554 thermal electric. Energy requirements are predicted to increase from 202 million megawatt hours in 1976 to 2,193 million megawatt hours by 2020. This would require an increase in installed capacity to 459,000 megawatts, comprising 10,000 megawatts hydro and 449,000 megawatts thermal capacity.

Recreation

The 5,500 miles of Great Lakes and island shoreline, inland lakes, park lands, beaches, forests, streams, trails, scenic highways, recreational harbors, and access sites provided about 200 million recreation days in 1978. Supply and the need often are not located in the same area. For example, the Lake Superior area contains about one-half the region's recreation land and water area but only about three percent of the region's needs. Conversely, the thickly populated Chicago, Detroit and Cleveland areas contain about one-half the region's needs but only about four percent of the supply. Distribution of water surface area shows a similar disparity between location of supply (northern areas) and needs (southern urban areas). However, some potential does exist in the southern portion, mainly the Great Lakes shoreline and flood plains of rivers. Annual recreational needs are predicted to increase to 455 million days by 2000 and 785 million by 2020.

Problems involved in developing a recreational program include competing land use, high land costs, complex ownership patterns, opposition to reservoir development and inadequate funds. Further, the quality of recreation is affected by natural and man-made contaminants from soil erosion and sedimentation, thermal pollution, shoreland development, solid waste disposal, shoreland erosion and air pollution.

It was estimated that some $2.5 billion would be needed to provide additional land and facilities during the 1970-2020 period, exclusive of an additional $1 billion for recreational boating facilities. Although the Corps of Engineers has constructed more than 200 harbors on the Great Lakes providing facilities for recreational boating, and there are at least that many private marinas, a demand for many more facilities, especially near metropolitan areas, is indicated.

Wildlife

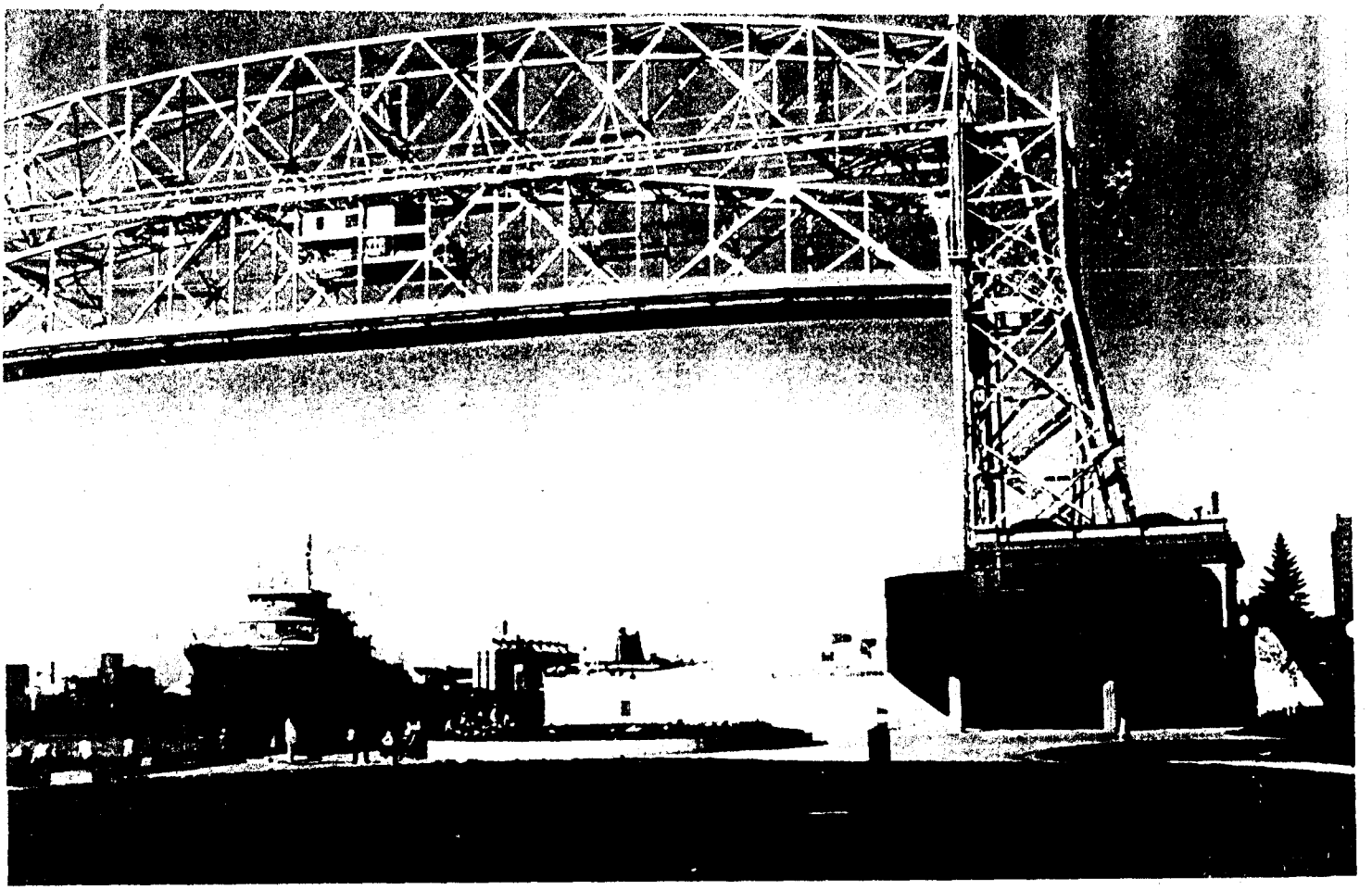
In the U.S. portion of the land area there are 75 million acres of wildlife habitat out of a total 84 million acres. Shoal waters total 550 thousand acres, of which 432 thousand are important to wildlife. All open waters are used by migrating waterfowl. The value of this habitat varies greatly, but the important consideration is that all land and waters have some value to wildlife.

Generally, the supply of wildlife habitat is good in the northern and northeastern areas and fair to the south. The country north of the Milwaukee- Buffalo line is forested and sparsely settled, while the region south of this line is heavily settled and primarily industrial and agricultural.

Wildlife includes big game, waterfowl, shorebirds, wading birds, song birds, small game and furbearers. Some species are classified as "endangered and threatened."

The most important factor affecting wildlife and wildlife habitat is human population density. The 1980 population was 30 million, and it is expected to increase to 46 million by 2030. Most of the increase will occur in the already heavily populated area. Wildlife managers are concerned that this population increase will cause both loss and degradation of wildlife habitat. It is estimated that demand for use of wildlife resources by both hunters and non- hunters will increase from 15 million man-days in 1978 to 30 million by 2030. The control of future development on wetlands and the creation of additional wetlands and refuges will benefit many species of animal, wildfowl, fish and plant life, as well as create additional recreational opportunities for man.

The Region contains approximately 139,000 acres of National Wildlife Refuge lands. Recreational use of these refuges is both non-consumptive (nature study, photography, picnicking, etc.) and consumptive (fishing and hunting). Many refuges have visitor interpretive centers or self-guiding automobile tours and walking trails.



The Canal Park Marine Museum constructed and operated by the Corps of Engineers gives visitors a historical perspective of shipping growth on the Great Lakes; it offers a commanding view of the Duluth-Superior Harbor area, Lake Superior, and the Duluth skyline. The museum, which was built to resemble a ship's bridge, is located directly in front of the Duluth aerial lift bridge.

Fish

Until about 1950, eleven species contributed significantly to commercial Great Lakes fishing-lake sturgeon, lake trout, lake herring, pike, chubs, lake whitefish, carp, suckers, catfish, yellow perch, and walleye. Reduction of stocks due to inroads by the sea lamprey and invasion by smelt and alewives, accelerated in some cases by overfishing, nearly have eliminated the first four from the commercial fishery. However, continued success of the lamprey control program and the introduction of new species (e.g. coho and chinook salmon) have improved both the sport and commercial fishing.

Many harbor breakwaters constructed by the Corps of Engineers are equipped with walkways, hand rails, parking areas and sanitary facilities to provide for sport fishing from the breakwater, in addition to fishing from boats that are berthed or launched at these harbors.

Conclusion

The Great Lakes area provides beautiful scenery, hunting, fishing, swimming, power boating and sailing; and agriculture, mining, manufacturing, power supply and transportation. These are all dependent upon water resources. Some uses are complementary, others are competitive. Prime consideration must be given to effects of any action on the environment and to restoring, preserving and improving the Great Lakes for the benefit of all users.

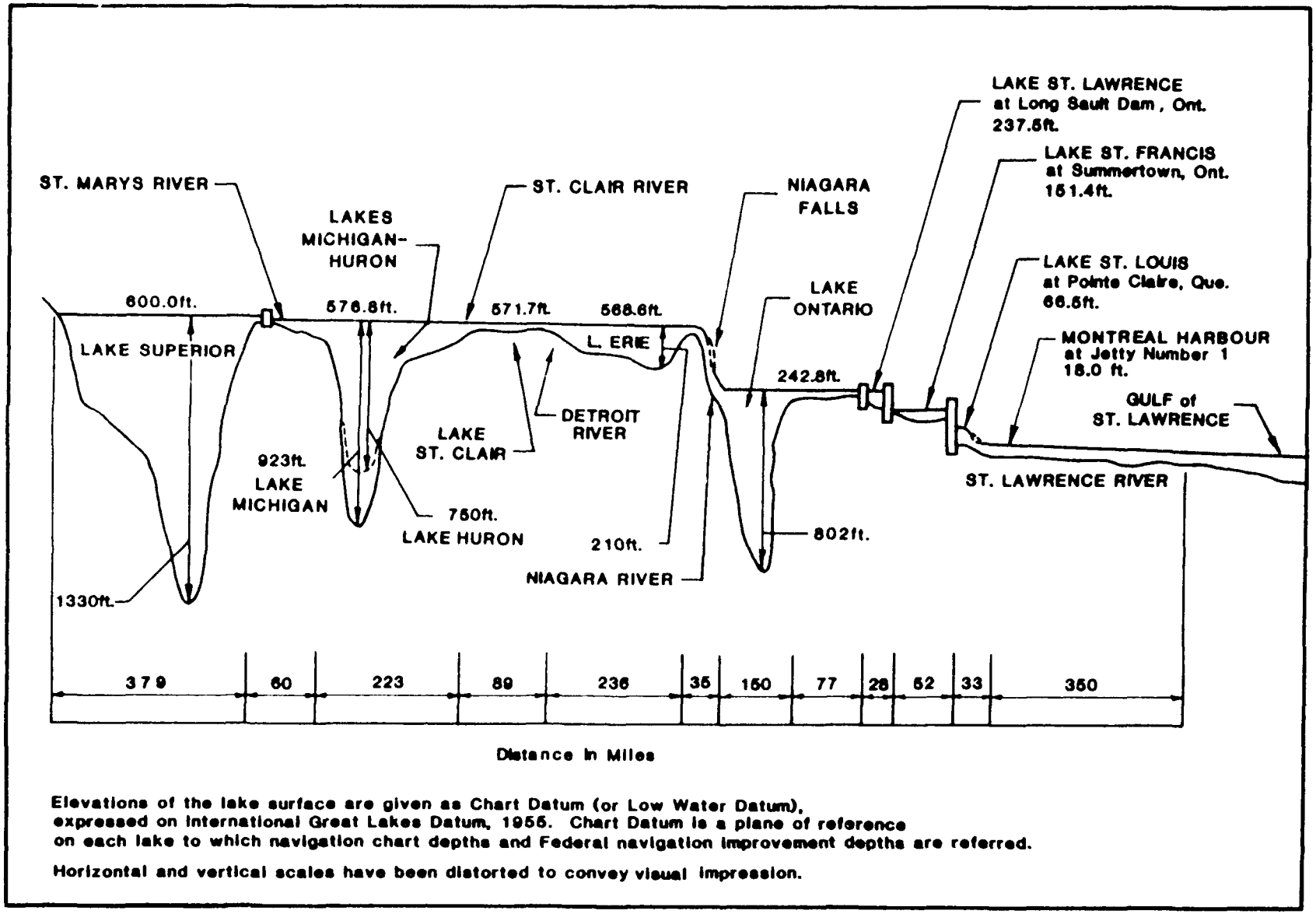
Commissions, Boards and Committees

This section provides brief descriptions of some of the commissions, boards, and committees involved in monitoring the use and development of water resources in the Great Lakes Region.

International Joint Commission

Over one-third of the boundary between the United States and Canada transverses the Great Lakes. Because of the nature of the lakes and their importance to the two countries, it long has been recognized that close international cooperation in their management and control is beneficial to both countries.

With the signing of the Boundary Waters Treaty of 1909, Canada and the United States established the International Joint Commission (IJC) to oversee issues concerning boundary and transboundary waters shared by the two countries, including the Great Lakes. The Treaty requires the IJC approve certain uses, obstructions or diversions of boundary waters if these operations affect the natural level or flow of the boundary waters in the other country. In addition, under the Treaty, Canada and the



Elevations of the lake surface are given as Chart Datum (or Low Water Datum), expressed on International Great Lakes Datum, 1955. Chart Datum is a plane of reference on each lake to which navigation chart depths and Federal navigation improvement depths are referred.

Horizontal and vertical scales have been distorted to convey visual impression.

PROFILE OF THE GREAT LAKES SYSTEM

United States can ask the IJC to conduct studies and make recommendations on specific problems along the common frontier.

The six-member (three U.S. and three Canadian) IJC is supported by staff at its offices in Washington, D.C. and Ottawa and Windsor, Ontario. The IJC also relies on the services of government and public experts from both countries to conduct its studies.

The outflows from Lake Superior and Lake Ontario are regulated in accordance with Orders of Approval issued by the IJC prior to construction of regulating works at their outlets. These Orders of Approval created Boards of Control whose function it is to oversee the operations of the control structures, formulate rules of regulation and see that the Orders of Approval are followed.

When the Governments refer a problem to the IJC for study, the Commission will usually establish a Study Board. The Study Board, consisting of qualified personnel from both countries, will organize and coordinate the field work and technical studies. The Board keeps the IJC informed by progress reports and, on completion of its studies, files a final report.

After releasing the Board's report the IJC holds public hearings. All interests have the opportunity to produce evidence and express opinions on the Board's report, or on an aspect of the problem that the Governments have referred to the IJC. The Commission formulates its own report and recommendations for submission to the two Governments. The IJC's report is not binding upon the Governments who have the responsibility for making the ultimate decisions.

Currently, the North Central Division of the U.S. Army Corps of Engineers is involved on the following IJC Boards and studies:

International Lake Superior Board of Control
International Niagara Board of Control
International St. Lawrence River Board of Control
International Great Lakes—St. Lawrence River Water Levels Reference Study

The first three are Boards which have operating responsibility within the Great Lakes, and the fourth is a study group. The North Central Division Commander is the ex-officio Chairman of the U.S. Sections of the three Control Boards, and Co-Chair of the Project Management team for the Reference Study.

International Lake Superior Board of Control

This two-member Board (one U.S. and one Canadian) is responsible for regulating Lake Superior outflows, under the terms of the IJC's Orders of Approval. It supervises the operation of a gated control structure built on the lake's outlet channel, and make allocations of water to the power interests located at Sault Ste. Marie, Michigan and Ontario.

The current regulation plan used to determine the monthly Lake Superior outflow incorporates the principle of balancing the levels of Lakes Superior and Michigan-Huron to provide benefits to the total Great Lakes system, without undue detriment to Lake Superior interests.

International Niagara Board of Control

This is a four member Board (two U.S. and two Canadian). It is responsible for supervising the maintenance and operation of remedial works on the Niagara River to preserve and enhance the scenic beauty of Niagara Falls and River while providing for the most beneficial use of waters for power generation. A gated control structure was constructed in the Niagara River under the U.S.-Canadian Treaty of 1950, to maintain the proper flow over the Falls. An ice boom at the outlet of Lake Erie, installed and removed annually by the power entities, helps to relieve some of the ice problems in the River during the winter and early spring.

International St. Lawrence River Board of Control

This board is responsible for insuring compliance with the provisions of the IJC's Orders of Approval relating to levels and outflows of Lake Ontario, the International Rapids Section of the St. Lawrence River and downstream.

The Board is composed of eight members (four U.S. and four Canadian). It is responsible for coordinating the regulation of Lake Ontario outflows and supervising the operation and maintenance of the St. Lawrence Seaway and Power Project as related to levels and flows.

International Great Lakes—St. Lawrence River Water Levels Reference Study

This study was begun in response to an August 1, 1986 Reference from the Governments of Canada and the United States. Under this reference, the IJC was asked to examine and report upon methods of alleviating the adverse consequences of fluctuating water levels in the Great Lakes-St. Lawrence River Basin. The Governments asked for an interim report, within one year, on possible short-term measures that could be used to alleviate the then (1985-86) high water crisis and also a final report fully addressing the long term strategies for responding to lake level fluctuations, both high and low.

Based upon the input of eight bi-national task groups, the IJC completed and sent its interim report, "Interim Report on 1985-86 High Water Levels in the Great Lakes-St. Lawrence River Basin", dated October 1988, to the two Governments. Recommendations noted in the report are mainly non-structural, pending completion of the ongoing comprehensive long-term study.

The magnitude and complexity of the comprehensive study requires that it be addressed in two phases. Phase I, which was completed in May 1989, identified the major types of measures which address the problems brought on by lake level fluctuations, and developed the basis for a comprehensive framework for the systematic evaluation of these measures. The IJC issued their Phase I progress report, titled "Living With the Lakes: Challenges and Opportunities," in July 1989. Phase II will apply several evaluation procedures, including a further development of the evaluation framework conceptualized in Phase I, to both structural and non-structural measures. The measures evaluated in Phase II will include shoreline management and full and partial lake regulations.

Great Lakes Commission

The Great Lakes Commission (GLC) was established in 1955 under the Great Lakes Basin Compact, an interstate agreement designating the Commission as a joint state body on Great Lakes water resource development, programs, and problems. Congressional consent was granted by Public Law 90-419 in 1968. The Commission is composed of from three to five representatives from each of the eight states bordering the Great Lakes. It meets at least twice annually and maintains offices and a staff in Ann Arbor, Michigan.

The Commission has been an active advocate on behalf of Great Lakes interests and acts as the primary forum for interagency coordination of water resources planning in the Great Lakes Basin.

The primary goals of the GLC are: (a) to provide a forum for discussion and study of common interstate water-related problems and for resolution of interstate water-related conflicts; (b) to coordinate the development of consistent Federal and state plans for water resources development within the basin; (c) to develop regional priorities for Federal water resources activities; and (d) coordinate the collection and interpretation of basic water and related land resources data.

Coordinating Committee on Great Lakes Basic Hydraulic and Hydrologic Data

The Coordinating Committee on Great Lakes Basic Hydraulic and Hydrologic Data (CCGLBHHD) was established in 1953 in the interest of developing a basis for derivation and acceptance of identical Great Lakes hydraulic and hydrologic data by both the United States and Canada. This group was formed by inter-agency agreement between the two countries and is not under the jurisdiction of the IJC. The Committee serves in an advisory capacity to the agencies of the United States and Canada who are charged with the responsibility of collecting and compiling Great Lake hydraulic and hydrologic data. The Committee has created four subcommittees: Vertical Control-Water Levels; Physical Data; Hydrometerology and Modeling; and River Flow. Each subcommittee has representation from both Governments. Personnel from the Corps of Engineers hold membership on the Committee and the Subcommittees.

The ongoing responsibilities of this committee include the coordination of Great Lakes water level, outflow, diversion and water supply data; and the coordination of outflow calculation and measurement techniques. In 1991, the Committee expects to announce a new International Great Lakes Datum - IGLD (1985). This will be the culmination of a complete releveling of all Great Lakes bench marks as referenced to sea level at the Gulf of St. Lawrence.

International Niagara Committee

This Committee was appointed by the Governments of the United States and Canada. It is responsible for determining and recording Niagara River flows and diversions for hydropower production to guarantee the requirements of the Treaty of 1950. This treaty provides that waters exceeding a specified minimum flow required to maintain the Niagara Falls scenic spectacle may be diverted for power.

Committee representatives periodically inspect all power plants in service to obtain independent power output readings and check water levels used to compute flows to verify compliance with treaty provisions. Investigations are made of any discrepancies, particularly between level data recorded on official gauges and by the power entities. In case of any violations of flow requirements over the Falls, an investigation is made and a written report prepared of each hourly occurrence. Corps personnel, in support of Corps membership on the Committee, verify the monthly hydraulic reports and prepare violation explanations for committee approval. The Committee's annual report summarizes the monthly reports. Copies of this report are forwarded to the U.S. Department of State.

Great Lakes Connecting Channels
Project Underway — Commercial Navigation
(Detroit District)

The Connecting Channels system includes the waterways between Lake Superior and Huron, Lakes Huron and Michigan, and Lakes Huron and Erie.

These vital links provide for deep-draft navigation between the upper and lower Great Lakes and associated deep-draft harbors serving the tributary area. The St. Marys River, Straits of Mackinac, St. Clair River, Lake St. Clair, and Detroit River constitute the connecting channels. Deep-draft vessels plying these channels carry bulk and general cargo essential to the nation's economy at far less cost than alternative modes of transportation.

Presently, improvements authorized by the 1946 and 1956 River and Harbor Acts essentially are complete, and provide generally for a minimum project depth of 27 feet in the connecting channels. This provides a safe draft of 25.5 feet for Great Lakes freighters when the level is at lower water datum. The difference between project depth and safe draft allows for squat of a vessel when underway and clearance due to exposure to wave action. These project depths have been available through the connecting channels since June 1962.

Construction costs of Channel improvements have amounted to over $271 million. Cost of maintenance through fiscal year 1985 totaled about $302 million.

Great Lakes Connecting Channels and Harbors
Completed Study — Commercial Navigation
(Detroit District)

The Great Lakes - St. Lawrence Seaway System extends from the Gulf of St. Lawrence on the Atlantic Ocean to the western end of Lake Superior — steamer track distance of 2,342 miles. The U.S. Army Corps of Engineers has maintained its support of commercial navigation on the upper four Great Lakes (Superior, Michigan, Huron and Erie) and the Connecting Channels since the late 1860's. The current system, which provides a

maximum safe vessel draft of 25.5 feet at lower water datum, was completed in the early 1960's. The last major civil works project on the upper system was the construction of the Poe Lock on the St. Marys Falls Canal, Sault St. Marie, Michigan, in 1968. There are 60 public and 15 private commercial harbors.

The Great Lakes Connecting Channels and Harbors Study was authorized by two resolutions of the Senate Committee on Public Works in 1960 and 1976. The purpose of the study was to determine the advisability of further improvements in the Great Lakes Connecting Channels and the commercial harbors for present and prospective commerce, and to determine the advisability of providing additional lockage facilities and increased capacity at the St. Marys Falls Canal.

Both an interim feasibility report and a final feasibility report have been completed under this study authority. As of September 1990, the final report is being held in the Office of the Chief of Engineers pending the identification of a local sponsor that is willing to cost share the project.

The final report contains a recommendation for construction of a replacement lock at the St. Marys Falls Canal on the site of the existing Davis and Sabin Locks. Replacement lock dimensions would be 1,294 feet in length, 115 feet in width, and 32 feet in depth over the sills at low water datum. Dredged material from construction of the lock would be disposed of in an environmentally acceptable manner by placing it on the Northwest Pier adjacent to the construction site. The project was authorized for construction by Congress in November 1986. This project authorization was extended in 1990.

The final report recommends deepening portions of the upper St. Marys River and Duluth Harbor by one foot so that downbound vessels can take better advantage of long-term mean lake levels that are much above low water datum on Lakes Michigan, Huron, and Erie. Other plans investigated in the final report included deepening Indiana Harbor for the iron ore trade on Lake Michigan, and modifications at Ashtabula and Conneaut Harbors on Lake Erie to improve operating conditions for vessels 1,000 feet in length.

During the course of this study, system-wide deepening of connecting channels and harbors was determined to be economically infeasible. Modifications to service vessels larger than those currently operating were also not warranted.

Great Lakes and St. Lawrence Seaway Navigation Season Extension Program
Completed Study — Commercial Navigation
(Detroit District)

The Great Lakes - St. Lawrence Seaway system extends from the Atlantic Ocean to Duluth, Minnesota, a route of 2,342 miles. It provides low cost, energy efficient marine transportation to and from the Nation's heartland. Each year, this important waterway was normally forced to close in mid-December due to weather and ice conditions — remaining closed until early April. Industry had to resort to stockpiling or shift to more expensive and less energy efficient modes of transportation during the winter months. Great Lakes bulk carriers laid up their fleet each winter, resulting in increased costs of operation.

The study, authorized by Public Law 91-611 and amended by Public law 93-251 and 93-587, consisted of three parts:

1. An Insurance Study was completed by the Maritime Administration in 1972, to evaluate ways to provide reasonable insurance rates for shippers and vessels during the winter months.

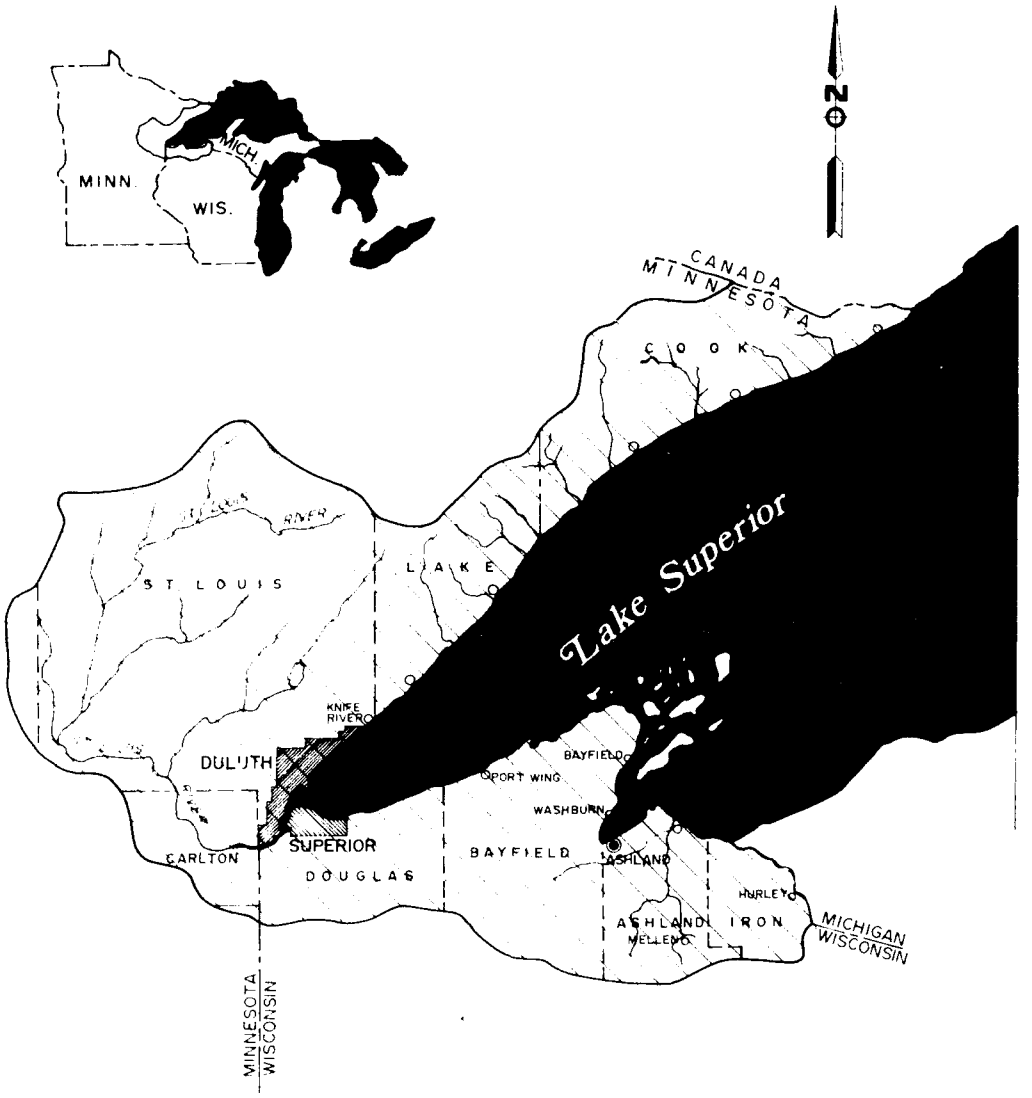
2. A Demonstration Program. The final demonstration program report was completed in September 1979. This program demonstrated that navigation season extension was practicable.

3. A Feasibility Study. An Interim Feasibility Report on a limited extension to January 31 (plus or minus two weeks) in the four upper Great Lakes was completed and forwarded to Congress for information by the Secretary of the Army on August 3, 1979 (House Document No. 96-181). The Interim Report recommends use of proven and existing operational measures to support the extension of the navigation season between ice-free harbors.

The Final Feasibility Report on season extension was completed in August, 1979. The Chief of Engineers concluded that season extension in the United States is primarily an operational matter for which responsible agencies have adequate authority, but for which specific measures may require additional authority; that further environmental and other analyses of the April 1 to January 31, plus or minus two weeks season on the upper four Great Lakes should be continued under present Corps operational programs; that navigation season extension of up to 10 months on the St. Lawrence Seaway - Great Lake System and extending up to about 10 3/4 months on the upper four Great Lakes is economically justified; and that Canadian coordination and participation for system-wide season extension should be pursued. The final report was sent to the Congress for information only. The study authority was subsequently deauthorized. Subsequent to the submission of the Feasibility Report, an October 1979 Supplement to the operations and maintenance EIS for the Sault Locks was completed addressing lock operations to 8 January plus or minus one week. In September 1989, a supplement to the operation and maintenance EIS was completed addressing lock operation to as late as 31 January plus or minus two weeks. In the August 1990 Record of Decision for this project it was determined to operate the locks annually to as late as January 15.

Chapter VIII

Lake Superior Basin



LAKE SUPERIOR BASIN

Lake Superior Basin

Geographic Area

The Lake Superior Basin is a long narrow watershed extending 350 miles from east to west and 150 miles north to south. Lake Superior is one of the largest freshwater lakes in the world with a volume of nearly 3,000 cubic miles and surface area of 31,820 square miles. The total drainage basin (land and water) is 80,511 square miles, of which 53 percent is in Canada, 30 percent in Michigan, 10 percent in Minnesota, and 7 percent in Wisconsin.

Major streams and tributaries draining the basin include the St. Louis, Bad, Montreal, Ontonagon, Sturgeon, and Tahquamenon Rivers.

Most of the basin lies within the Superior Uplands. It is characterized by rugged uplands and a rock escarpment bordering parts of the lake. Nearly 90 percent of the area is classified as forest land. A maximum altitude of 2,301 feet occurs at Eagle Mountain near Grand Marais, Minnesota, and 1,800 and 2,000 foot altitudes are common.

Lake Superior elevation is 600 feet. In Minnesota, an upland glacial-lake plain is drained by the upstream reaches of the St. Louis River. Other glacial- lake lowlands cover much of the Wisconsin part of the basin and areas of the eastern portion.

Vegetation and Wildlife

The basin's vegetation is dominated by a northern spruce-fir forest. Bogs and their associated plant species also are common, as are aspen stands. Climate and poor soil conditions preclude highly productive agricultural activity; thus allowing the large forested areas to remain intact.

Wildlife species reflect the low population density and the thick forest cover. The timber wolf exemplifies this best, requiring a vast unbroken wilderness with few human intrusions. He also requires white-tailed deer and moose populations as well as smaller mammals to sustain him through the winter. Other basin species include coyote, red fox, snowshoe hare, ruffed grouse, black bear, bald eagle, osprey, short-tailed grouse, woodcock, spruce grouse, bobcat, lynx, and furbearers including otter, fisher, beaver, mink, muskrat and pine marten.

Climate

The basin experiences a typical mid-continental climate, which is modified considerably by the waters of Lake Superior.

Prevailing winds and storms are from the west and southwest, which may cause great extremes of weather conditions and temperatures. The Keweenaw Peninsula serves to deflect storms crossing the region from the west. The lake is so large that there are appreciable climate differences between the north and south shores and also between the western and eastern ends of the basin.

Lake Superior, because of its heat storage capacity, may warm winter air masses moving over the region as much as 15° to 20°F.

Mean temperatures for the basin during July range from an 80° maximum to a mean minimum of 50°F. Winters tend to be severe and temperatures of 30°F below zero are not uncommon for the interior western highlands.

Average annual precipitation ranges from 28 to 36 inches. Snowfall averages better than 100 inches annually—portions of Michigan's Keweenaw Peninsula, Ontonagon, Gogebic, Alger, and Luce Counties, receiving from 120 to 170 inches.

Annual freeze-free periods range from 150 days along the lake shore to 90 days inland. Cool air and surface water temperature tend to limit water sports on Lake Superior.

Recreation

National and state parks, numerous inland lakes and streams containing some of the highest quality waters east of the Mississippi River, and extensive forests are the major sources of outdoor recreation within the basin.

Excellent hunting, fishing, sightseeing, camping, hiking, boating, and other recreational opportunities exist. The climate and terrain also offer an excellent setting for winter sports activities.

Among the recreational resources in the basin are Isle Royale National Park, Boundary Waters Canoe Area, Voyageurs National Park, beaches of Whitefish Bay, dunes and cliffs of the Pictured Rocks National Lakeshore, Tahquamenon Falls, the Huron and Porcupine Mountains, and Apostle Islands National Lakeshore.

In addition to existing recreational areas, new sites could be developed in portions of more than six million acres of public forest land. Development of small-boat harbors on Lake Superior is also desirable to keep pace with the increasing demand for recreational boating.

Population and Land Use

Natural resources played an important role in the economic development of the region. For nearly three centuries the French Canadian voyageurs were the dominant figures of the fur trading era. Industrialization later spurred the growth of mining and lumbering activities. Because of the vast expanse of forest land, the lumber industry has become widespread. However, mining of iron ore is, and will continue to be, the one most significant economic factor in the basin's economy.

The least populated of the five Great Lakes basins, the Lake Superior Basin had a 1980 population of about 548,000, an increase of 5 percent from 1970. The estimated 1989 population for the Minnesota and Wisconsin portions of the lake Superior Basin is about 320,000. Recently, the Lake Superior region has experienced high unemployment and low income. As a result, there has been a significant emigration of workers. Major economic problems relate to marginal agricultural activity and a decline in markets for forestry and mineral products. Projections indicate urban expansion will be minimal between now and the year 2020.

Commercial Navigation

About 77.8 million short tons of cargo were shipped on Lake Superior in 1989. Of this total, approximately 63.3 million tons were domestic traffic and 14.5 million tons were foreign. Cargo consisted mainly of iron ore, grain, coal and limestone.

Water resources development in the Lake Superior Basin includes projects in Minnesota, Wisconsin, and Michigan. Detailed descriptions of Corps projects and activities in the Minnesota portion of the Lake Superior Basin are provided in the following pages.

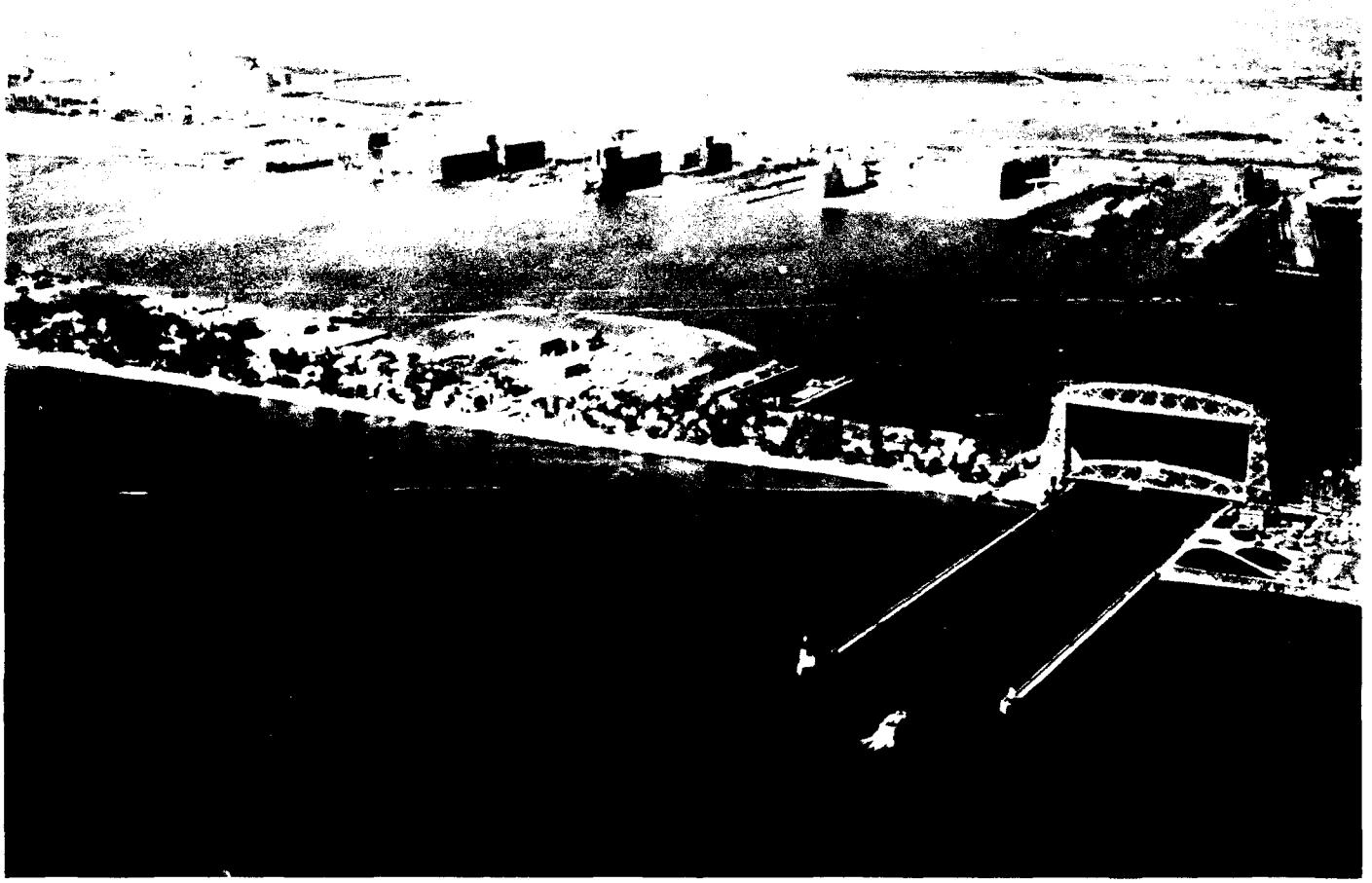
Duluth-Superior Harbor,
Completed Project —
Commercial Navigation
(Detroit District)

Duluth-Superior Harbor is located between Duluth, Minnesota and Superior, Wisconsin. Formed by the waters of the St. Louis River and Bay and Superior Bay, the harbor is separated from Lake Superior by sand and gravel barriers, known as Minnesota Point and Wisconsin Point. The original project for the harbor at Superior was authorized in 1867 and for Duluth in 1871. The ports were combined in 1896, and since have been expanded and modified by 10 River and Harbor Acts, the latest in 1960 when increased depths were authorized to accommodate deep-draft Great Lakes vessels.

Ships enter the harbor from Lake Superior either through Duluth Ship Canal, located in the northern portion of the harbor, or through Superior Entry in the southeastern part of the harbor. Piers of concrete and timber construction line the entrance channels and two breakwaters in the form of an arrowhead protect Superior Entry from lake storms. The improved portion of the harbor consists of 17 miles of dredged channels and anchorage areas, or maneuvering basins, providing 27-foot depths for iron ore traffic, 23-foot depths for coal and grain traffic, and 20- to 21-foot depths in tributary channels. These Federal improvements permit access to the 113 private land-based facilities servicing the harbor. Superior Front Channel, with 27-foot depths, provides a 600-foot connecting channel between entrances. Pleasure craft also may use numerous small bays off the main commercial channels.

All harbor improvements, including deepening authorized in 1960, are completed except for deepening the 21st Avenue West Channel. This portion of the project was deauthorized on 31 December 1989 as required by the Water Resources Development Act of 1986, Public Law 99-662.

The Water Resources Development Act of 1986 authorized improvements to the harbor including deepening the North, South, Upper and Minnesota Channels, widening the Cross Channel Turning Basin and widening the turn of the Old Arrowhead Bridge and construction of an upland disposal facility. The total project cost at October 1990 price levels is



Entryway at Duluth Harbor

$16,827,000 of which $9,327,000 is the Federal share and $7,500,000 is the non-Federal share. Construction work is scheduled to being during 1991.

Total cost of the project was $16,109,258 through September 1990, which includes $1,547,195 spent on previous projects. About $47,900,220 has been spent on maintenance of the harbor through September 1990 with an additional $1,556,249 spent for a confined disposal facility. Rehabilitation costs through September 1990 were $11,000,420.

The average annual traffic from 1980 through 1989 was about 35,088,609 short tons consisting primarily of shipments of iron ore and grain and the receipt of coal and limestone. Traffic in 1989 amounted to 40,802,541 tons. This port is one of the most important Great Lakes ports for overseas commerce.

Grand Marais Harbor
Completed Project — Commercial and Recreational Navigation
(Detroit District)

This project, authorized by the River and Harbor Act of March 3, 1879 with later modifications, is located in a natural cove on the northwest shore of Lake Superior at Grand Marais. Within the harbor, an anchorage basin of about 36 1/2 acres for commercial craft has been dredged to a depth of 16 feet, with increased depths of 18 to 20 feet at the entrance of Lake Superior. The natural opening of the harbor has been narrowed by the construction of breakwater piers, each 350 feet in length, from the east and west points of the bay. A basin for small boats in the northwest portion of the harbor was completed in 1960. It is 100 feet wide, 520 feet long, and 8 feet deep, protected on the south side by a rubble-mound breakwater 921 feet long connected to the shore at the westerly end.

The cost through September 1990 for improvements to the harbor was $451,000. This includes $209,800 for the commercial harbor and $241,200 for the small boat harbor. Maintenance costs through September 1990 total $1,992,626 and rehabilitation costs were $1,230,000.

Two Harbors
Completed Project — Commercial and Recreational Navigation
(Detroit District)

The project, authorized by the River and Harbor Act of August 5, 1886 with later modifications, is located in Agate Bay on the northwest shore of Lake Superior at the town of Two Harbors. The originally authorized work, completed in 1950, narrowed the natural entrance by construction of two breakwaters, 1,628 and 900 feet long, from the eastern and western points of the bay, respectively. A maneuvering area on the north and east sides of the harbor also was dredged.

The 1960 River and Harbor Act authorized increasing the depth of the maneuvering area from 28 to 30 feet to accommodate Lake Superior deep-draft traffic. Most of the authorized dredging was completed in 1962, except for rock removal in areas along the easterly and northerly edges of the harbor, which was completed in 1980.

The cost through September 1990 of harbor improvements was $4,170,710 for new work and $2,318,790 for maintenance. From 1963 to 1965, the harbor was used only by commercial fishing and recreational craft. Other commercial traffic began in 1966. Currently, commercial traffic consists primarily of iron ore and concentrates. Traffic in 1989 amounted to 10,535,909 tons and has averaged about 9,058,742 tons annually over the past 10 years.

Beaver Bay Harbor
Project Underway — Recreational Navigation
(Detroit District)

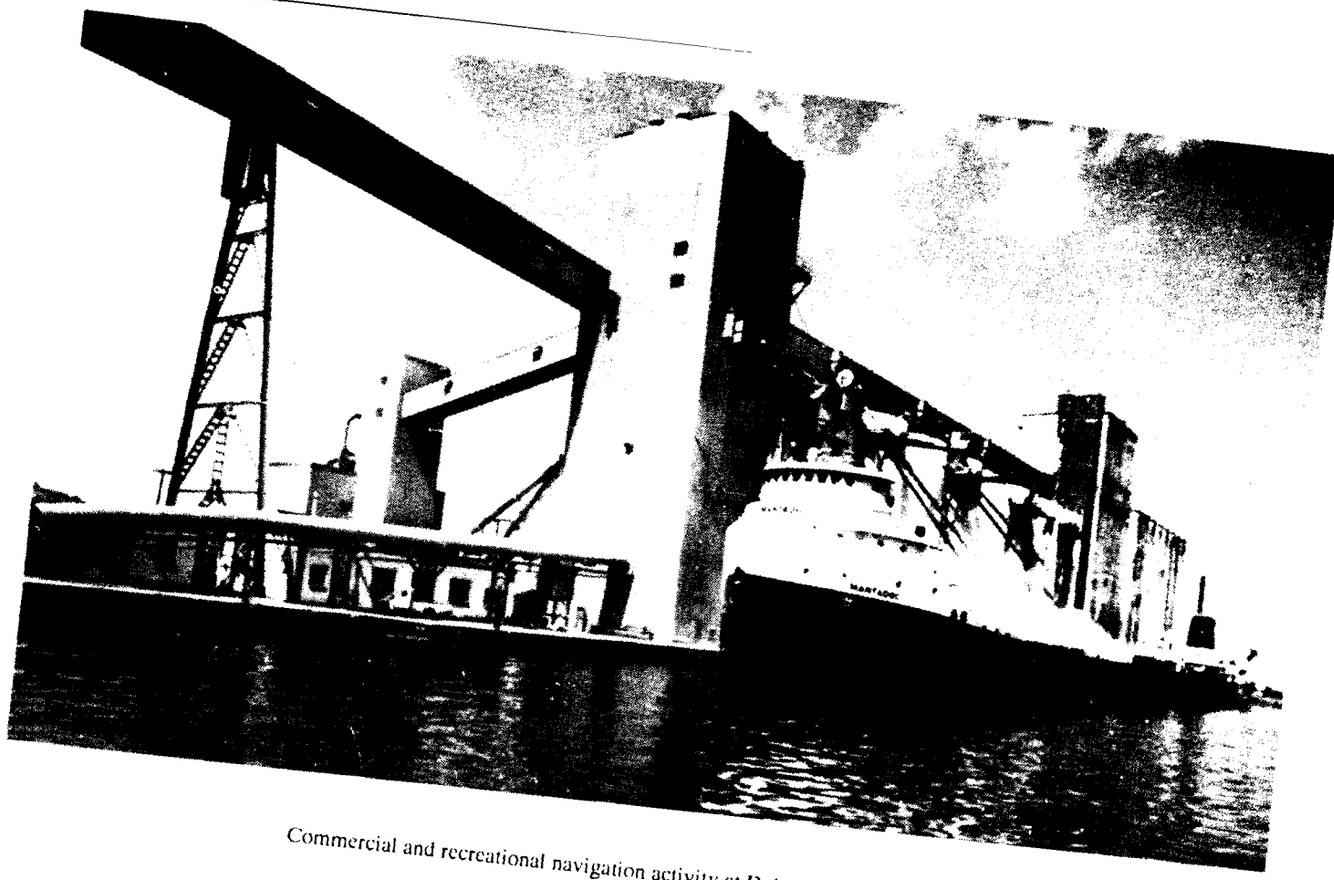
The 1945 River and Harbor Act authorized improvements at Beaver Bay along the northwest shore of Lake Superior. The proposed plan of improvement provides for a rubblemound breakwater having a single steel sheet piling cell on each side of the harbor entry for a total length of 650 feet, with an excavated harbor basin approximately 2 acres in size, and 8 feet deep.

Light draft vessels face danger from the severe northeasterly and northwesterly gales and storms, which frequently occur during the spring and fall and from heavy fog, sudden squalls, and thunderstorms which are frequent during the summer. Construction of the proposed project will provide a safe harbor of refuge along the north shore of Lake Superior where it is located one mile northeast of the authorized site. The nearest adequate harbors of refuge are located 56 miles northerly to Grand Marais Harbor and about 27 miles southwesterly to Two Harbors.

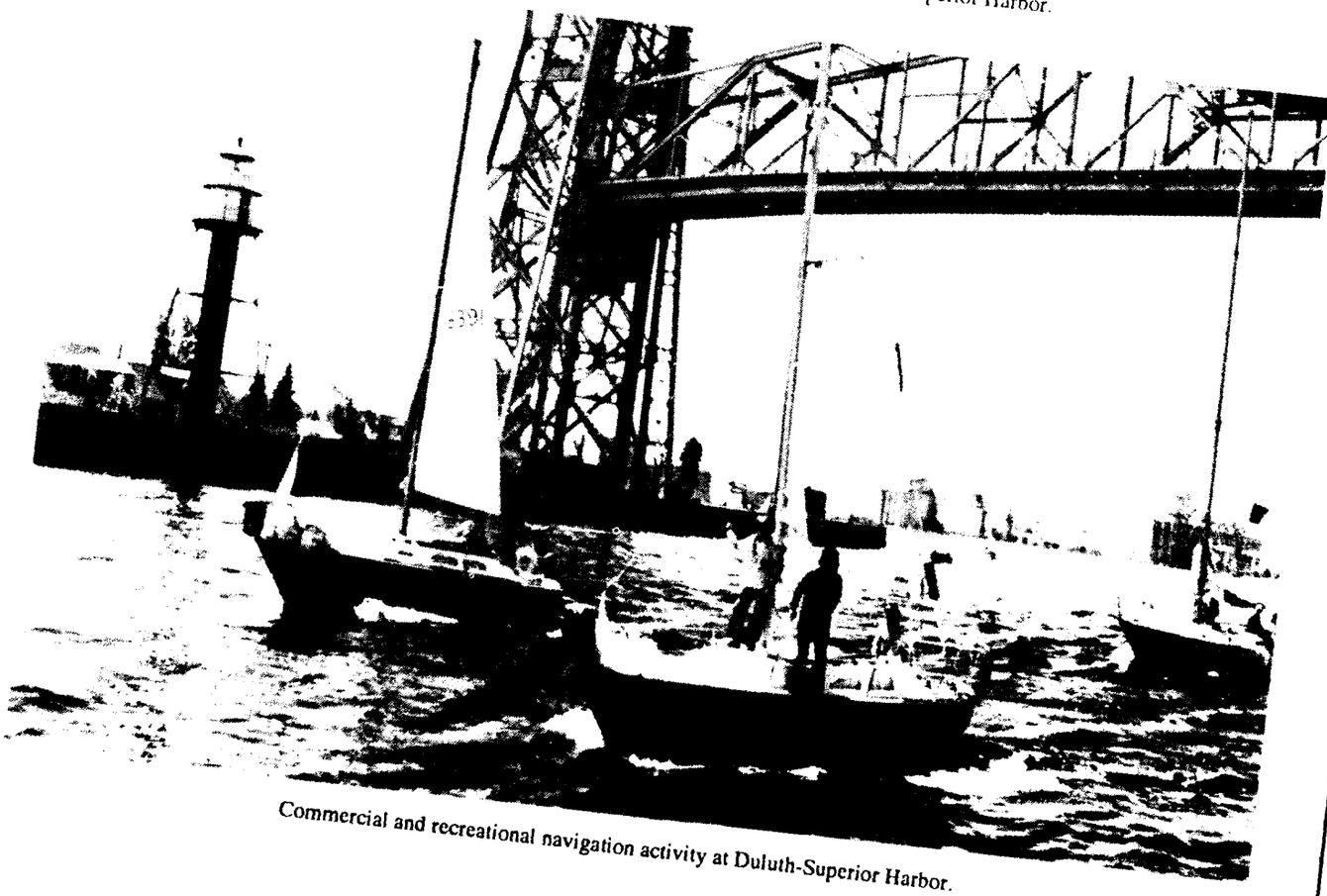
The estimated Federal cost of the project is $1,822,000 with non-Federal costs of $1,940,000 (October 1990 price levels). The project is available for construction should funds be appropriated.

Knife River Harbor
Project Underway — Recreational Navigation
(Detroit District)

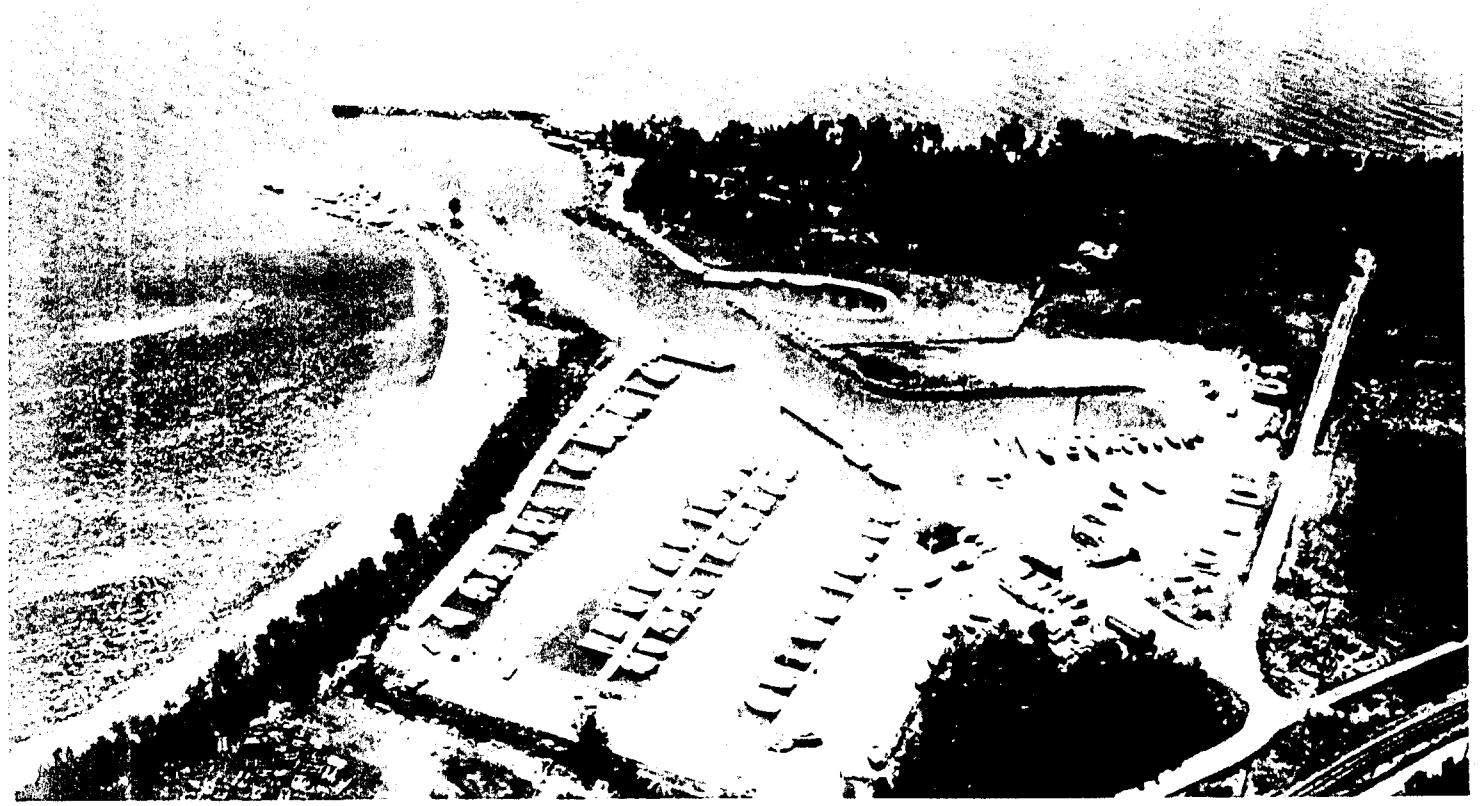
The harbor is located about 20 miles northwest of Duluth and about one-third of a mile south of the mouth of the Knife River on the northwest shore of Lake Superior. The project, authorized by the 1945 River and Harbor Act, provided an entrance channel of varying widths, 10 feet deep in the lake approach; an inner straight channel 8 feet deep, 50 feet wide, and 600 feet long, with a spending beach at its inner end having a radius of 150 feet; northerly and southerly side channels 8 feet deep, 50 feet wide and 150 to 250 feet long, respectively; and a breakwater about 240 feet long on the south side of the entrance.



Commercial and recreational navigation activity at Duluth-Superior Harbor.



Commercial and recreational navigation activity at Duluth-Superior Harbor.



Knife River Harbor

The project was completed in June 1958. Total project costs through September 1990 were $702,169 of which $412,945 was for new work and $289,224 was for maintenance.

The existing breakwater does not effectively prevent waves caused by northeasterly winds from entering the entrance canal. The Water Resource Development Act of 1974 authorized a breakwater modification to correct the deficiency in the original design. The modification would provide an improved harbor of refuge for recreational and commercial boaters on Lake Superior. The estimated Federal cost (October 1990) of the project is $1,272,000, with an equal amount required as the non-Federal contribution. After funds have been allocated, two construction seasons will be required for completion.

Lutsen Harbor
Project Underway — Recreational Navigation
(Detroit District)

The 1945 River and Harbor Act authorized improvements at Lutsen near the mouth of Poplar River on the northwest shore of Lake Superior. The site has since been relocated to near the mouth of the Cross River at Schroeder, Minnesota. The proposed plan provides for two rubblemound breakwaters totaling 1,166 feet in length, and an excavated harbor basin of approximately two acres in size with an 8-foot depth.

Small vessels face danger from spring and fall storms and from heavy fog, sudden squalls, and thunderstorms which are frequent during the summer. The project will provide a safe harbor of refuge along the north shore of Lake Superior where it is relocated 11 miles southwest of the authorized site. The nearest adequate harbors of refuge are located about 30 miles northerly to Grand Marais and about 53 miles southwesterly to Two Harbors.

Estimated Federal cost of the project is $5,102,000 with non-Federal costs of $5,270,000 (October 1990 price levels). The project is available for initiation of construction should funds be appropriated.

Two Harbors
Study Underway, Section 107—
Recreational Navigation
(Detroit District)

Two Harbors is approximately 26 miles northeast of Duluth, Minnesota along the northwest shore of Lake Superior. While the existing breakwaters currently provide protection for commercial vessels, there is not adequate space or protection for a recreational craft harbor within the protected area. The study, authorized under Section 107 of the River and Harbor Act of 1960, as amended; was undertaken in response to a July 18, 1978 resolution adopted by the City Council of Two Harbors regard-

ing the feasibility of developing a small-boat harbor at Burlington Bay in Two Harbors. Based on the reconnaissance report, construction of a small-boat harbor appears economically feasible, environmentally acceptable, and in the Federal interest. However, because of the budget deficit and current policy, work on recreational projects has been indefinitely deferred.

Two Harbors, Lake Superior
Completed Project, Section 14—
Emergency Bank Protection
(Detroit District)

A reconnaissance study of the problem of bank erosion at the site of the Two Harbors public works facilities was requested by the Two Harbors City Council in September 1974. The study was completed in April 1975 under the authority of Section 14 of the 1946 Flood Control Act, as amended. Construction of the project was completed in 1978 at a cost of $107,000.

Duluth
Authorized Study Not Underway,
Shoreline Erosion Control
(Detroit District)

A project was authorized by Section 616 of the 1986 Water Resources Development Act that would provide shoreline protection measures for the 3,200-foot-long runway at Sky Harbor Municipal Airport in Duluth. The proposed project includes riprap shore protection, fueling area repairs and protection, and topsoil and turf establishments. Initiation of a study is dependent upon the availability of funds.

**Confined Disposal Program —
Lake Superior**

In December 1970, Public Law 91-611 authorized the construction of contained dredged material disposal facilities on the Great Lakes for maintenance dredging. The law provided for facilities to confine dredged material from harbors which have been declared contaminated by the U.S. Environmental Protection Agency. Most Lake Superior harbors in Minnesota have either received a non-polluted classification or require relatively small quantities of maintenance dredging which can be unloaded to shore and placed at approved on-land locations. Duluth-Superior Harbor is the only harbor where a diked disposal facility has been constructed. The facility is located in the Minnesota portion of the harbor in West Duluth and will contain maintenance dredged material from the entire harbor for a period of 10 years. The facility consists of earthen dikes and, upon completion of filling, will provide a land area of approximately 85 acres. Construction of the project was completed in November 1979 at a cost of $1,556,000. The disposal facility is an integral part of the maintenance dredging program for the harbor.

An additional disposal facility on Lake Superior for Keweenaw Waterway, Wisconsin was completed in 1988 at a cost of $941,382.

Future confinement facilities will be constructed under regular project authorities rather than Public Law 91-611.

Glossary

Acre-foot: An area of one acre covered with water to a depth of one foot. One acre-foot is 43,560 cubic feet or 325,851 gallons.

Advance engineering and design work: After authorization by Congress of a project design and engineering work leading to contract plans and specifications for construction.

Agricultural levee: A levee that protects agricultural areas where the degree of protection is usually less than that of a flood control levee.

Air bubbler: A device on the bottom of a body of water which releases compressed air forming bubbles that transports warmer bottom water to the surface to retard ice formation.

Appropriation: The setting aside of money by Congress, through legislation, for a specific use.

Authorization: House and Senate Public Works Committee resolu tion or specific legislation which provide the legal basis for conduct ing studies or constructing projects. The money necessary for ac complishing the work is not a part of the authorization, but must come from an appropriation by Congress.

Bank and channel stabilization: The process of preventing bank erosion and channel degradation.

Basin: (1) Drainage area of a lake or stream as: river basin. (2) A naturally or artificially enclosed harbor for small craft as: yacht basin.

Beam: The maximum port-to-starboard width of a ship, boat, or other vessel.

Biochemical oxygen demand: The amount of dissolved oxygen in parts per million required by organisms to enable them to decompose the organic matter present in the water.

By-channel: A channel formed around the side of reservoir past the end of the dam to convey flood discharge from the stream above the reservoir into the stream below the dam.

Clear blue ice: Ice of low air-content which has frozen rapidly in unagitated water.

Closure structure: A movable structure built along a levee or floodwall at street or railroad intersections to prevent floodwaters from flooding the area protected by the levee or floodwall.

Confluence: The place where streams meet.

Control dam: A dam or structure with gates to control the discharge from the upstream reservoir or lake.

Crest length: The length of a wave along its crest.

Dam: A barrier constructed across a valley for impounding water or creating a reservoir.

Damages prevented: The difference between damages occuring with out a project and the damages with the project in place.

Deep-draft harbor: A harbor designed to accommodate commercial cargo vessels having drafts greater than fourteen feet.

Deep-girder channel span: A structure, usually a bridge, made up of steel plates, angles, etc., to span navigation and flood control channels.

Degree of protection: The magnitude of flooding that a flood control measure is designed for, usually expected as a statistical estimate of how often such a flood would occur, i.e., "a 100-year flood."

Dike: An embankment to confine or control water, and/or soil, See also Levee.

Diversion channel: (1) An artificial channel constructed around a town or other point of high potential flood damages to divert floodwaters from the main channel of a river to minimize flood damages. (2) A channel carrying water from the diversion dam.

Draft: The vertical distance from the waterline to the bottom of a floating vessel.

Dredged material: Earth, gravel, sand, silt and clay removed in excavation or dredged in access canals, boat or navigation channels, drainage ditches, and lakes.

Earthfill dam: A dam the main section of which is composed princi pally of earth, gravel, sand, silt and clay.

Environmental Assessment (EA): A planning report which presents the first thorough examination of alternative plans that positively demonstrates that the environmental and social consequences of a Federal action were considered. If the EA concludes that the proposal is a major Federal action significantly impacting on the quality of the human environment an environmental impact state ment will be required.

Environmental Impact Statement (EIS): A report required by Section 102(2) (c) of Public Law 91-190 for all Federal actions which significantly impact on the quality of the human environment. The EIS is a detailed and formal evaluation of the favorable and adverse environmental and social impacts of a proposed project and its alternatives.

Feasibility study: An evaluation of a water resources problem to determine if a proposed work is technically, environmentally and economically sound.

Flank levee: A levee constructed nearly perpendicular to the streamflow.

Flat pool: The pool on the upstream side of a navigation lock and dam where the water surface level is nearly horizontal or has a very mild slope.

1% flood: This is the same as a 100-year flood and is a flood which has a 1% chance of occurrence in any year.

Flood capacity: The flow carried by a stream or floodway at bank-full water level. Also the storage capacity of the flood pool at a reservoir.

Flood crest: The highest or peak elevation of the water level during a flood in a stream.

Flood plain: Valley land along the course of a stream which is subject to inundation during periods of high water that exceed normal bank-full elevation.

Floodproofing: Techniques for preventing flood damage to the struc ture and contents of buildings in a flood-hazard area.

Floodwall: Wall, usually built to reinforce concrete, to confine streamflow to prevent flooding.

Freeboard: (1) Vertical distance between the expected maximum level of the water in stream or reservoir. (2) An allowance in protection above the design water surface level.

Gate bays: The gate bay walls include those portions of the lock in which the gate recesses, gate anchorages, gate machinery and some times culvert valves and culvert bulkheads are located.

Gravity drainage outlets: (1) Outlets for gravity drains such as tiles, perforated conduit, etc. serving an agricultural area and discharging into a drainage ditch. (2) Pipe, culvert, etc., used for dewatering ponded water by gravity.

Groin: A wall-like structure built perpendicular to the shore to trap sand and prevent beach erosion.

Guide pier: A structure which extends from the entrance to a lock, used to guide vessels safely into the lock.

Habitat: The total of the environmental conditions which affect the life of plants and animals.

Headwaters: (1) The upper reaches of a steam near its source. (2) The region where goundwaters emerge to form a surface stream. (3) The water upstream from a structure.

Ice booms: Structures installed across channels to retard to flow of ice but not that of water.

Ice floes: Free-floating sheets of ice, usually at least several inches thick, on a stream, lake or sea.

Ice Jam: Accumulation of ice packed together and piled up, choking the stream channel and causing a rise in water level above the jam.

Interceptor sewer: A conduit that receives flow from a number of smaller sewers or outlets and conducts such waters to a point for treatment or disposal.

Jetty: On open water, a structure extending into a body of water designed to prevent shoaling or a channel by littoral material and to direct stream or tidal flow. Usually built at the mouth of a river to help deepen and stabilize a channel.

Left or right bank of river: The left-hand or right-hand bank of a stream when the observer faces downstream.

Levee: A dike or embankment, generally constructed close to the banks of the stream, lake or other body of water, intended to protect the landside from inundation or to confine the streamflow to its regular channel.

Lift: The difference in elevation between the upstream and down stream water surface levels in a lock and dam system.

Lift span bridge: A bridge having a movable span which remains horizontal while being lifted vertically by cables arranged through towers at both ends.

Lift station: A small pumping station that lifts to a higher elevation when the continuance of the sewer at reasonable slopes would involve excessive depths of trench.

Light-draft craft: A small boat, usually recreational, having a draft of about ten feet or less.

Littoral drift: Material such as sand that is swept along the littoral zone by waves and current.

Littoral zone: The narrow area, including the land and water, bordering the shoreline.

Lock: An enclosed part of a canal, waterway, etc., equipped with gates so that the level of the water can be changed to raise or lower boats from one level to another.

Lock operation: Locks fill and empty by gravity, with no pumps required to raise or lower the water level. To raise the water level valves are opened above the upper gates and water flows into the lock through tunnels in both lock walls. This process is reversed to lower water in the lock. Valves are opened below the lower gates and water drains out of the lock through the tunnels. Gates at both ends of the lock open and close electrically after the proper water level has been reached.

Low water datum: A standard reference elevation, unique for each Great Lakes, to which all depthson hydrographic charts are referred.

Meander: The name given to the winding course of a stream or river.

Miter gates: A type of gate commonly used to trap water in a lock changer.

Mouth of river: The exit point of discharge of a stream into another stream, a lake or the sea.

Oxbow lake: A lake formed int he meander of a stream, resulting from the abandonment of the meandering course due to the formation of a new channel course.

Pier: A structure which extends from the shore out into the lake and serves primarily for mooring and landing of boats. Also, the term is sometimes used synonymously with jetty.

Pile dike: A dike constructed of posts or similar piling driven into the soil.

Ponding area: An area reserved for collecting excess runoff prepara tory to being discharged either by gravity or by pumping.

Pool: A small and rather deep body of quiet water as water behind a dam.

Preconstruction planning: Additional planning before project con struction, usually done during a project's postauthroization stage. See also Advance engineering and design work.

Pumping station: A structure containing pumps which is used to evacuate runoff from behind levees during periods when high river levels prevent gravity drainage.

Reach: A length, distance, or leg of channel or other watercourse.

Recurrence interval: The statistically derived probability of occurence of a flood event, converted to a time interval (e.g. a 1% chance flood = 100 year flood).

Rehabilitation: A major repair job. Usually involves considerable reconstruction of already existing structures.

Reservoir: A pond, lake, tank, basin, or other space either natural or created in whole or part by the building of a structure such as a dam, which is used for storage, regulation, and control of water for power, navigation, recreation, etc.

Retardin dam: A dam used to reduce the floodflow of a stream through temporary storage.

Revetment: (1) A facing of stone, concrete, sandbags, etc., to protect a bank of earth from erosion. (2) A retaining wall.

Riprap: A layer, facing, or protective mound of randomly placed stones to prevent erosion, scour, or sloughing of a structure or em bankment. The stone so used for this purpose is called riprap.

River basin: A water resource basin is a portion of a water resource region defined by a hydrological boundary which is usually the drainage area of one of the lesser streams in the region.

River region: A water resource region is a major hydrologic area consisting of either the drainage area of a major river, such as the Missouri River, or the combined drainage areas of a series of streams.

River tow: An assemblage of one or more barges propelled by a towboat in a riverine waterway.

Rock dike: An embankment built principally of rock.

Sandbag closure: A temporary closure structure consisting of sand bags. This closure may be found where a levee or flood-wall has a sudden change in elevation such as in a street crossing. Sandbags are used to close the street in times of high water to prevent flooding.

Sedimentation basin: A basin or tank in which water or wastewater containing settleable solids is retained to remove (by gravity) a part of the suspended matter.

Sediment load: The total sediment composed of suspended load and bed load transported by a stream. The suspended load is composed of fine sediment transported in suspension while bed load is com posed of relatively coarse material transported along or near the bottom.

Self-liquidating facilities: Facilities provided by local interests at a project site in addition to facilities which are part of the federally cost-shared project features. These facilities are considered to be self-liquidating in that they can be paid for through user fees charged the public. These facilities might include such things as a public wharf, mooring facilities, parking areas, etc.

Shoal area: Patches of sand, gravel, or other hard bottom lying at shallow depths.

Sill: (1) A horizontal beam forming the bottom of an entrance to a lock. (2) Also, a low submerged damlike structure built to control riverbed scour and current speeds.

Slack-water area: (1) In tidal waters, the area where tidal current velocity is at a minimum; especially the movement when a reversing current changes direction and its velocity is a zero. (2) In streams, a place where there is very little current.

Slough: (1) A small muddy marshland or tidal waterway, which usually connects other tidal areas. (2) A tide land or bottom land creek. A side channel or inlet, as from a river or bayou, that may be connected at both ends to a parent body of water.

Spending beach: A beach inside a harbor, designed to reduce wave action by absorbing wave energy.

Spillway: A waterway or a dam or other hydraulic structures used to discharge excess water to avoid overtopping of a dam.

Spoil material: (See Dredged material).

Squat: The vertical downward displacement of a craft under power with respect to its postion in the water when not underway.

Stage: The elevation of the water surface above or below an arbitrary datum.

Standard project flood: A flood that may be expected from the most severe combination of meteorological and hydrological conditions that are reasonably characteristic of a geographical region involved, excluding extremely rare combinations.

Stop-log closure: Logs, planks, cut timber, or steel or concrete beams fitting into end guides between walls or piers to close an opening in a dam or conduit to the passage of water. The logs are usually placed one at a time.

Swale: (1) A slight depression, often wet and covered with vegetation. (2) A wide, shallow ditch, usually grassed or paved.

Swing span bridge: This is the span of a bridge across a navigable stream that rotates to allow tall ships to pass through the bridge.

Tainter gate: A semi-circular gate which opens and closes through pivoting on a shaft and is used to control the flow of water over spillways.

Thermal discharge: The heated water, such as that from nuclear power plants, that is discharged into a stream or other body of water.

Tributary: A stream or other body of water that contributes its water to another stream or body of water.

Trussspan: A structure made up of a number of bars, fastened together at their ends to form a rigid framework.

Uncontrolled spillway: An overflow spillway having no control gates.

Vertical lift gate: A gate that moves vertically in slots or tracks in piers and consists of a skin plate and horizontal girders which transmit the water load into the piers.

Watershed: The whole surface drainage area that contributes water to a collecting river or lake.

Wave-absorbing breakwater: A breakwater is a structure protecting a shore area, harbor, anchorage or basin from waves. A wave absorbing breakwater protects by absorbing, rather than reflecting the wave energy.

Wing dam: A wall, crib, row of pilings, stone jetty, or other barrier projecting from the bank into a stream for protecting the bank from erosion, arresting sand movement or for concentrating the low flow of a stream into a smaller channel.

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